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The Dock & Harbour Authority

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No. 427

Vol. XXXVII.

MAY, 1956

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Editorial Comments

Reconstruction of Gallions Entrance Lock, Port of London.

The depth of water to be provided in sea-ports is a subject of perennial study by port authorities. The tendency for ships to increase in draught presents problems arising partly out of the necessarily permanent nature of dock structures and the heavy cost of replacing them.

An ingenious method of providing an improvement in depth in a ship lock has recently been put into practice by the Port of London Authority. Although no major extension to the Authority's dock systems has yet been made, very considerable improvements have been carried out since the war, and amongst these is the reconstruction of the Gallions Lower Entrance Lock to the Royal Docks, which is described in an article by Mr. G. L. Spear, the first instalment of which is published in this issue.

This lock, which has been in continuous use since 1886, had a nominal depth of 36-ft. below Trinity High Water (Thames High Water Datum), but this depth could not be wholly utilised because of the shape of the lock bottom which, reflecting the shape of ships' hulls at the time of the lock's construction, was in the form of an inverted arch. When it became necessary to effect extensive repairs to the lock, it was decided to remove the restriction in depth by cutting out the rising sides of the arched bottom, rendering the bottom more nearly rectangular in section and providing an effective increase of about 4-ft. in depth.

The conception and its successful design and construction reflect great credit on those responsible.

Permanent International Association of Navigational Congresses

In our last issue reference was made in these columns to the 19th Congress of the above Association, which is to be held in London from July 8 to 16, 1957. The Permanent International Association of Navigational Congresses was formed in 1885 to discuss the construction and operation of waterways and ports, which in the 19th century were termed "navigations." Its main work is accomplished at International Congresses, subjects of current importance to port, harbour and waterway authorities being selected for discussion.

The Association, which has its headquarters in Brussels, now has the support of 50 member countries, and individual membership conveys the right to participate in all Congresses, and to receive the Papers and Proceedings, together with the Bulletin which is issued half-yearly.

The affairs of each national section of the Association are managed by national committees: in this country by the British National Committee, with headquarters at the Institution of Civil Engineers, Great George Street, London, S.W.1. The membership from all countries totals more than 2,100, of whom only 75 are resident in the U.K. The British National Committee wish to call attention to this comparatively small representation, which they feel is not consonant with the country's interests and traditions as a maritime and seafaring nation. They commend membership, at the relatively small rates of subscription, to all Port, River and Local Authorities, Harbour and River Engineers, Contractors, Industrialists, Manufacturers of dock equipment, Shipbuilders, Shipowners and others who they feel would benefit from and contribute to the international exchange of information. Any of our readers who are interested can obtain further information from the Secretary of the British Section, or from this Journal.

The Distribution of Wave Heights

Of special interest to Civil engineers and others concerned with harbour construction and maintenance, is an article which appears on another page on the Distribution of Wave Heights. The author, who is on the staff of the National Institute of Oceanography, describes a statistical method whereby the distribution of wave heights at a given site may be assessed with very fair accuracy from one year's observations. In the case of a site where the problems caused by waves of significant height are confined to one of two seasons of the year, the statistical method can be applied to observations taken over the relevant periods, thus abbreviating the period during which records require to be taken.

The above method, combined with the facilities which now exist for analysing wave length frequency distribution, should be of considerable value in the preparatory stages of harbour construction. It may also be useful in situations where, due to the increase in tonnage of modern ships in recent years, fresh problems of mooring have been created. There may well be harbours in which a modicum of "range" generated by the waves outside has hitherto presented no problem. Larger ships will however respond to different frequencies of "range," and its harmonics, and an accurate statistical analysis of the causative factors will be a useful preliminary to devising an antidote.

Improved Facilities at Larne Harbour

The Phoenix and Curran Quays, built at a cost of £120,000 were formally opened at Larne Harbour early this month by Lord Wakehurst, Governor of Northern Ireland These extensions will provide additional or alternative accommodation for the normal Larne-Stranraer passenger and goods service, and the rapidly expanding cross-channel container and car ferry services.

Although primarily undertaken to improve the Larne-Stranraer mail service, in view of the modern trends in cargo handling methods, the original plans were amended to allow for the growing traffic in loaded lorries and container cargoes. For this new type of transport, large parking and manoeuvring areas are required close to the quayside, and so the new works have added 717-ft. of quay frontage and six acres of ground to the harbour facilities. In addition, there is a new heavy-duty ramp capable of meeting all tides and of carrying loads of 120 tons on wheels from lorry-carrying vessels. A new 15-ton crane will deal with the cargoes.

Reclamation of the area from the sea involved the dredging of approximately 75,000 cu. yds. of the sea-bed and the use of some 250,000 tons of waste material for levelling. This was reinforced by 1,200 tons of steel sheet piling and 2,700 cu. yds. of concrete. An interesting feature of the construction has been the inclusion of two "Mulberry" caissons, each weighing 3,000 tons, which were used on the Normandy beaches for the invasion of Europe during the Second World War. Work on the extensions to Larne harbour commenced in 1951 and is now nearing completion. In addition to the increased berthing space, there will also be a depth of water of 21-ft. at H.W.O.S.T., giving accommodation for vessels up to 5,000 tons.

Editorial Comments—continued

The importance which Larne harbour attaches to supplying adequate accommodation for the new container and "roll-on, roll-off" traffic is significant, especially in view of the growing number of Continental ports that are supplying similar facilities. It will be interesting to see how these new systems of cargo transport effect the economies of other ports which, owing to physical limitations, cannot make the same provision.

Library of Technical Information

In these days of expanding scientific and industrial knowledge, there is such a quantity of technical information being written that it must be a major problem for engineers and scientists to ensure that they do not miss any printed matter that is issued on new technical developments. Not to be in possession of all the relevant information available can be a disadvantage and a time-wasting factor and, with the present competition from Continental and other foreign countries, it becomes essential that such time should not be lost.

The Liverpool and District Scientific and Industrial Research Library Advisory Council has therefore been started to supply technical information to the Merseyside area. An industrial liaison committee has been formed to advise the council and, as the cost of running the service is considerable, leading industrial concerns have been asked to subscribe towards it. Each company contributing 100 guineas or more to the service is allowed a representative on the committee. In the belief that the organisation is likely to be of great assistance to the industrial progress of Liverpool, the City Council have agreed to double certain of the contributions to the service, which will act as a link between the region and the national research associations.

It appears likely that this scheme, which is believed to be the first of its kind in Great Britain, will attract considerable attention in other industrial centres, for the lack of sufficient reference libraries of modern technical information has long been a handicap which many engineers and scientists would like to see overcome.

Topical Notes

Proposed New Thames Tunnel.

The Minister of Transport and Civil Aviation announced recently that the main contract for constructing the mile-long Dartford-Purfleet Tunnel under the Thames has been let to Edmund Nuttall, Sons & Co. (London) Ltd. The total cost is estimated at more than £10 mn., approximately £6,000,000 of which will be accounted for in the contract for driving and lining the tunnel and the construction of its immediate approaches.

The project provides for a single tunnel carrying a roadway for two lanes of traffic. It will be 4,700-ft. long and is to be situated in Long Reach where the river is half a mile wide. There will be nearly a third of a mile of cuttings between the tunnel portals and the points at which the roadway emerges at ground level, and the roadway will fall from the tunnel entrances towards the river on gradients of 1 in 28, with a short section practically level underneath the river. It will be 100-ft. below high water level at the lowest point of the tunnel. The approach roads are to be constructed with twin two-lane carriageways. It is anticipated that the scheme will take about five years to complete and that more than 2,000,000 vehicles will use the tunnel each year.

It is expected that, when completed, the tunnel will ease traffic congestion in London, particularly in the area of the docks.

Second Oil Refinery at Southampton.

Southampton Harbour Board have given approval in principle to amended plans submitted by Caltex Services, Ltd., for the installation of oil jetties off Warsash to serve a second oil refinery on Southampton Water. This scheme is a new one, although based on a previous scheme submitted by an associate company in 1951, and as now proposed, it meets the objections put forward by the Board at former applications.

The Caltex Company state that if the jetties were built, about eighty-three 32,000 ton and a hundred and twenty-eight 16,000 tons ships would use the port each year. Arrivals and departures would average about one ship every 1.75 days.

The Board's Works and Harbours Committee, in addition to approving in principle the establishment of the jetty, proposed that consideration of the conditions to be attached to the Board's consent be deferred. In the meantime, the Board's officers would consult with the Company on details of the proposal, including the re-alignment of the jetty, the making of a tidal model at the company's expense, engineering plans and possible future extensions. The sub-commissioners of pilotage are to be consulted when the plans have been further developed.

A jetty in the vicinity proposed will affect other traffic in the port of Southampton, such as yachts, and the Board wish to make adjustments in the detail planning in order to satisfy any objections. Lay-up berths for repairs are not being planned and lay-up anchorages would only be used in emergency if vessels were held up. Coaster berths on the inshore side of the jetties will be considered and, if found safe and economical, may be installed. Any further extensions would be to the southward.

President of the Institute of Transport 1956-57.

Mr. Francis H. Cave, M.Inst.T., General Manager and Secretary, Mersey Docks and Harbour Board, and a Vice-President of the Institute, has been elected President of the Institute for 1956-57, and will take office on October 1st next.

Mr. Cave was elected to Membership of the Institute in 1944 and served as a Member of Council from 1949-54. He was Chairman of the Merseyside Section 1952-53, and has been a Vice-President since 1954. He is the author of a number of papers on port subjects and is Chairman of the Conference on Port Education convened by the Institute.

Mr. Cave has been General Manager and Secretary of the Mersey Docks and Harbour Board since March, 1954. He entered the Board's service in August, 1926, as Assistant to the Chief Traffic Manager and 11 years later was appointed Chief Traffic Manager, a post which he occupied throughout the 1939-45 war when he and his staff were responsible for the clearance of dock quays and the rapid dispatch of cargo through the port. He was a member of the Port Emergency Committee and a Chairman of its Sub-Committee appointed to deal with the allocation of transport. In 1946 he was appointed Deputy General Manager of the Board.

Mr. Cave is a Member of the Liverpool Dock Labour Board and Chairman of the Executive Committee of the Dock and Harbour Authorities' Association. He has travelled extensively in the United States, Canada and on the Continent to study port design and operation.

New Quay at Port of Belfast.

Details have been announced of a new quay to be built at Belfast for the shipment of turbines made at the British Thomson-Houston factory in Larne. The quay will be equipped with a 200-ton crane, the order for which has already been placed with Sir William Arrol and Co. Ltd., of Glasgow, and which should be ready in two years' time.

Although the new berth will cater chiefly for the products of the British Thomson-Houston Company, the Belfast Harbour Board expect that it will also be used for other cargoes, and financial assistance has been afforded to the scheme by the Northern Ireland Government.

The new quay, which will be on the west side of the channel, will be 650-ft. in length and will have a depth of water alongside of 28-ft. below the harbour datum, with provision for eventual deepening to 33-ft. It will be equipped with a 170-ft. shed and will be designed for the operation of 7½ ton mobile cranes and will also have a crane track capable of carrying 10-ton travelling cranes.

Royal Group of Docks, Port of London

Reconstruction of Gallions Lock Entrance

By G. L. SPEAR, A.M.I.C.E.

1. History.

PRIOR to 1921 when the King George V Dock was completed, the Royal Group of Docks consisted of the Royal Victoria and Royal Albert Docks. The main lock leading to both was the Gallions Lower Entrance, which had been built as an extension to the Royal Albert Dock.

The Entrance, which was opened in 1886, was constructed by direct labour at a cost of £328,830*, and was designed to accommodate the then largest ship in the world†. The leading dimensions were:—

(a) length between inner and outer gates 550-ft.;
(b) length between middle and outer gates 400-ft.;
(c) width 80-ft.;
(d) depth nominally 36-ft. below Trinity High Water‡.

It was not many years, however, before the rapid development of ships found the lock limiting not only the size of vessel using the Royal Docks to about 12,000 gross register tonnage but also the number of larger ships passed through on each tide.

However, the addition of the King George V Dock in 1921 with its much larger lock and depths enabled the Group to accommodate ships up to about 36,000 gross register tonnage. This greatly eased the overloaded locking conditions at the Gallions Lower Lock but the limitations in the size remained. Normally this did not affect the operation of the Docks but on the rare occasions when the King George V Lock has been out of operation this proved a severe handicap. (See Fig. 1.)

Gallions Lower Lock was in almost continuous operation from 1886 onwards until after the second world war when it became obvious that a major overhaul was necessary.

Because of the intention to increase the effective locking depth by altering the lock bottom, it was necessary to carry out all the work in the dry. Dams were thus required at both ends of the lock as well as the provision of a deep well ground water lowering system around the whole area. (See Fig. 2.)

2. Extent of Lock Improvements and Repairs.

It was impossible to ascertain beforehand the exact nature and extent of many of the "below water" repairs due to the difficulties of underwater inspection in silt laden water. In addition the lock bottom is always covered to some extent by a layer of dense mud. For this reason the Contract was of the "Measured" type and included provisional sums for works the exact nature of which could only be determined after dewatering the lock.

Briefly the works included in the Contract were:—

(a) Increasing the effective depth of the lock.
(b) Repair and improvements of the granite gate cills.
(c) Repair and improvements of the granite gate quoins.
(d) Refacing of the lock wall in reinforced concrete.
(e) Resurfacing damaged gate platforms and bellmouth apron.
(f) Construction of emergency cills and quoins at the extreme ends of the lock to enable the gates to be used as dams for any future dewatering.
(g) Reconstruction of the service mains culverts under the lock.
(h) Alterations to the outer sluice outlet vents to prevent undesirable scouring off the end of the apron.
(i) Provision of new double skin semi-buoyant gates in place of the original single skin roller path type.
(j) Replacement of all lockside machinery by conversion from hydraulic to electrical operation.
(k) Provision of electrical interlock system for gates and sluices.
(l) Reconstruction of timber lead-in jetties mainly in Ekki timber.

* Labourer's hourly wage 1886—5¼d.; 1956—3s. 8d.
† Excluding "Great Eastern."
‡ Trinity High Water is the datum on the River Thames and is at approximately M.H.W.S.T. All levels refer to Works Datum which was 100-ft. below Newlyn Datum.

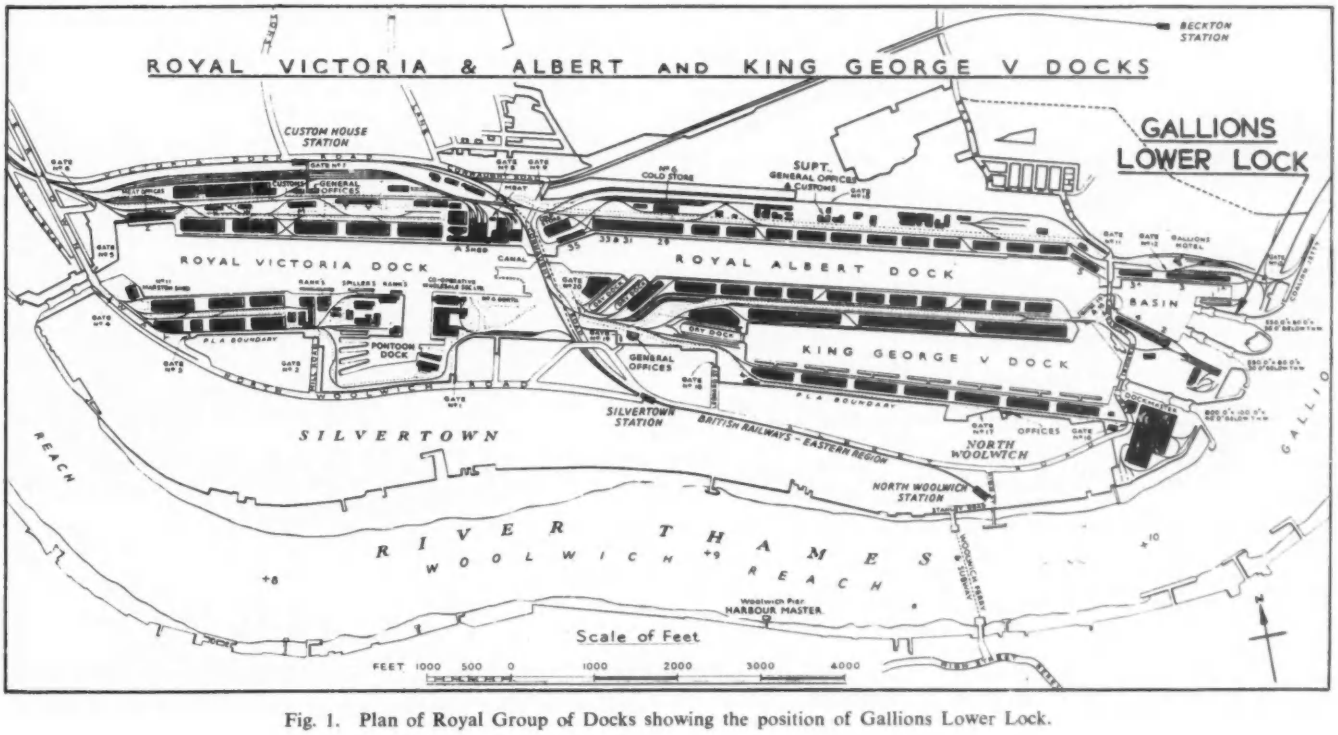


Fig. 1. Plan of Royal Group of Docks showing the position of Gallions Lower Lock.

Port of London—continued

(m) Provision of spring fender beams at extremity of southern jetty.
(n) Provision of new lockside accommodation.

Fig. 2 (above). Aerial view of Gallions Lower Lock during reconstruction. The working area, as can be seen, was mainly on the island between the two locks. The lock on the left is normally used for small craft due to limited locking draught. Fig. 3 (below) General view of lock during early stages of reconstruction. The 110-ft. radius curved invert, kentledge loading on lock bottom and wall struts can be seen clearly.

3. The Contract.

The principal Contractors were Messrs. John Mowlem & Co. Ltd., and the time taken to complete the main section of the work was 4½ years, during which the labour force on the site averaged 130 men.

The total cost of the works was in the region of £1,000,000 but of this sum nearly 30 per cent. was for temporary works which were of considerable magnitude both by reason of the nature of the work and because of the risks involved, which included the possible accident of a ship breaching the inner dam and so flooding the works. If this had occurred at time of low water in the river, the outer dam might have collapsed under the reverse head and released the impounded water from all three docks.

In addition the Contractor was called upon to provide a series of deep wells throughout the area with the object of reducing the standing level of the ground water around the lock to about invert level. These wells were to be kept in continuous use during the period when the lock was dried out and were to be complete with standby power supply for immediate use in case of the failure of the public electricity supply.

The running cost of this dewatering item alone, excluding installation, was in the region of £1,000 per week.

4. Site Investigations.

A series of boreholes, including some through the lock invert, was made on the site before the Contract was let. In addition, the Contractor in sinking his deep wells and making certain local investigations, obtained additional information regarding the lock structure and ground strata.

The top of the chalk was found to be about 10-ft. below the lock invert and overlaid by Thames ballast which varied in thickness from 13-ft. to 20-ft. thick. Over the ballast was a layer of clay of 12-ft. average thickness followed by filling material of clay, peat and other debris from the original excavation over the site.

Various tests were carried out both on site and in the laboratory and amongst the results obtained were the following:—

1. **Ballast.** Angle of internal friction 37° loose 42° in situ.
   In situ penetration resistance of 1¼-in. dia. cone at 7 to 9-ft. depth. 2,500 to 4,000 lbs./square inch.
2. **Chalk.**
   (a) Undrained samples.
   Angle of internal friction—zero.
   Average shear strength—50 lbs./sq. inch.
   (b) Drained samples.
   Angle of internal friction—31°.
   Average shear strength—12.5 lbs./sq. inch.
   (c) In situ penetration resistance of 1¼-in. diameter cone at 5 to 18-ft. depth, 600 to 900 lbs./sq. inch.
3. **Friction between concrete and ballast.**
   Precast block with very smooth base—29° rising to 32°.
   Precast block with moderately smooth base 33°.
   Block cast in situ on ballast—36°.

5. Inner Dam.

The Contractor elected to construct a mass type gravity dam in the Royal Albert Basin

Port of London—continued

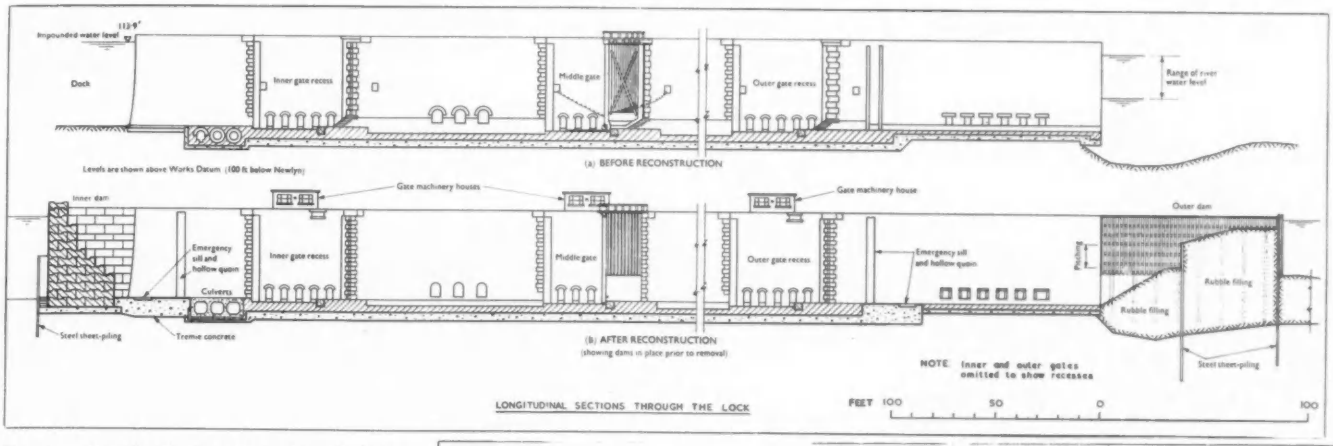


Fig. 4. Longitudinal section through lock, before and after reconstruction.

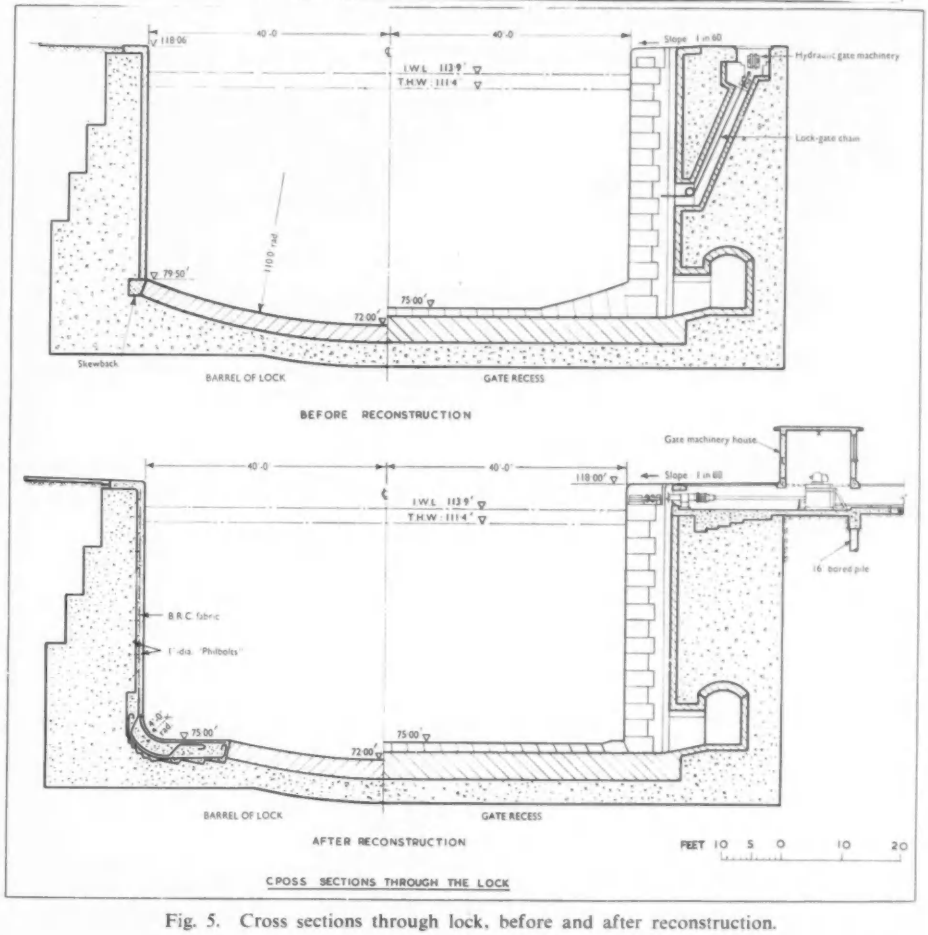


Fig. 5. Cross sections through lock, before and after reconstruction.

just beyond the inner end of the lock, and this was founded on a bed of mass concrete placed under water on the ballast and surmounted by coursed blockwork. A cut-off to prevent the percolation of dock water was formed outside the dam by a curtain of steel sheet piling. Fig. 4 includes a typical section through the dam.

The dam was protected from floating craft by a very strong fender consisting of a series of 12-in. by 12-in. steel girder trestles, framed and braced in heavy timber.

A continuous construction platform was cantilevered out on the inside of this fendering and provided the necessary gate for driving of a steel sheet pile cut-off which was No. 3 Larssen section. The platform was used later by the divers and their plant for the laying and subsequent removal of the concrete blocks of the dam.

The steel sheeting of the cut-off wall was driven 10-ft. into the chalk and the space between it and the blocks allowed to pack up with mud. This sealed off the dock water from the base of the dam and thereby prevented hydrostatic uplift under the dam.

The foundation of the dam itself was constructed by grabbing out the ballast down to the required level and then forming a series of bays each measuring about 16-ft. by 34-ft. with steel rail screeds carried on sandbag walls forming the side shutters. These bays were concreted by divers using bottom door skips and carefully screeded to level.

As the success of the dam depended to a large extent on the accuracy of this foundation, the Contractor ensured that the level was correct to plus or minus $\frac{1}{4}$-in. In the foundation there was a total of thirteen bays and, including grabbing out to formation, each bay took about 10 days to complete.

The first course of blocks in the foundation was laid using 12-in. x 12-in. broad flange beams as guides. As these had to be very carefully lined up by plumb bobs with the surface survey, progress on the bottom course was limited to two blocks each day. Once this course was completed, however, the rate of laying increased to an average of 14 per day. The space between the dock wall and the return ends of the dam was filled progressively with skip concrete laid between concrete bagwork shutters.

The total number of blocks laid in the dam was 1,350 and each block weighed about 11 tons. The blocks were constructed of vibrated 8 to 1 ballast concrete and easily achieved the required crushing strength of 2,500 lbs. per square inch at 28 days. All blocks were joggled to facilitate placing and give positive resistance to sliding in an emergency. In addition, all those forming part of the pressure face were provided with a grooved edge so designed that, in conjunction with the groove on the edge of the adjacent block, a three-quarter circle groove was formed. (Fig. 6 is a photograph showing the dam.)

On completion of the dam these grooves were sealed by placing a canvas hose in them and filling with cement grout under pressure. This filled the groove most effectively and sealed the joint.

After the dam had been completed it was tested and found that the mud accumulating between the block courses during the laying had reduced the coefficient of friction to about 0.30 so that an additional course of blocks was necessary on top of the dam to

Port of London—continued

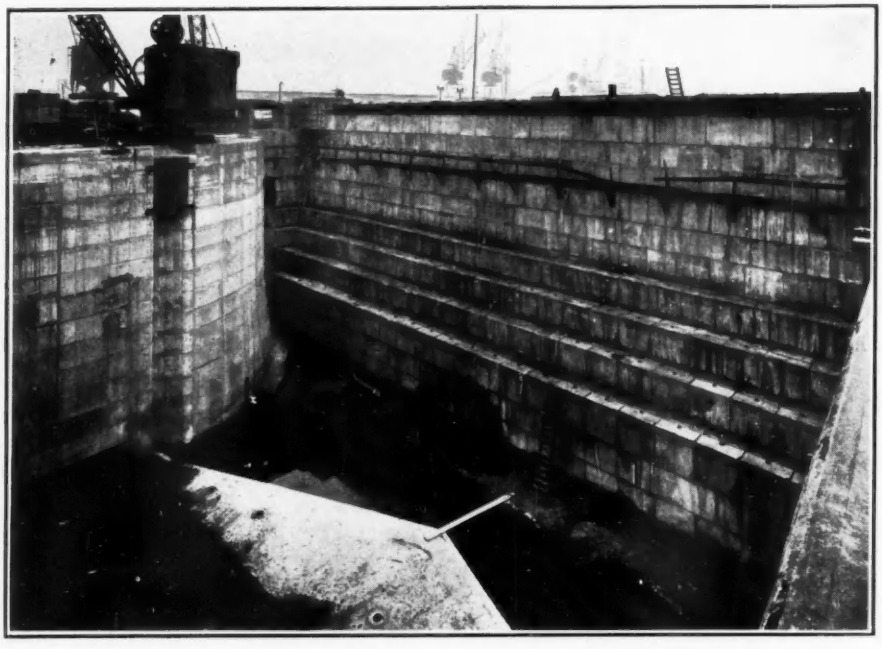


Fig. 6. Inner dam back face and inner emergency dam position. Note the small leakage past blockwork dam and the pressure release vent holes of the emergency dam position.

develop the necessary resistance between courses.

6. Outer Dam.

Originally it had been intended that a concrete block dam should also be constructed at the river end of the lock but, because of the poor quality of the chalk foundation in the bottom of a scourhole off the end of the apron it was decided to construct a hardcore gravity dam. Fig. 4 includes a typical section.

The dam consisted of two rows of steel piling spaced 45-ft. apart connected together by a series of walings and tie rods. The cut-off consisted of No. 3 Appleby-Frodingham piling used for the river side row which returned through the line of the jetties to connect into the old cofferdam of the original construction on one side, and the old river wall on the other. The piling was in 70-ft. lengths and had at least 10-ft. penetration into the chalk. The inner row of piling was No. 3 and No. 5 Larssen, but this only spanned the width of the bellmouth between the jetties.

After the piling had been driven the section between the piles was grabbed down to firm chalk and hardcore then deposited up to river low water level. The hardcore berms on either side were also constructed similarly.

Just above the low water level four concrete culverts of 21-in. in diameter were laid through the dam connecting with penstocks constructed in the outer row of piling. With these penstocks the lock was kept tidal until it was dewatered. The hardcore filling between the two rows of piling was continued up to high water spring tide level.

Part of the hardcore used in the construction of the dam was obtained from London and St. Katharine Docks, part of which, during the war, had been used as an emergency dump for blitzed building debris. The material was brought down the river by barges and transferred by grab to the dam. The remainder of the hardcore was brought in by lorry and particular care was taken to ensure that that which was used for the inner berm was of the heavier type such as old granite sets, so that sufficient resistance was developed without the material spreading over the bellmouth apron. A view of the dam looking towards the River Thames is shown in Fig. 7.

7. Ground Water Lowering and Other Safeguards.

To protect the works during reconstruction the Contractor was required to provide a system of ground water lowering complete with emergency power supply, to place 10 tons per foot run of kentledge along the centre of the lock invert and to carry out all necessary strutting.

(a) Deep Well System.

For the ground water lowering it was required that the hydrostatic uplift under the invert should be reduced to at least less than the dead weight of the invert. The nature of the soil strata around the lock with the gravel overlaying the chalk made conditions suitable for a deep well system and this was adopted. (See Figs. 8, 9, 10.)

Initially twenty wells were driven, ten on each side of the lock. The wells were 24-in. external diameter with 12-in. centre tube and were driven to an average of 71-ft. below ground level.

The wells were equipped with Beresford submersible pumps varying from 11 to 16 h.p. and discharged into an 8-in. diameter ring main which in turn discharged into the dock and the river.

The wells were spaced approximately 80-ft. apart and 50-ft. from the lock coping, but were so arranged that they avoided the various proposed new buildings. Five observation wells were also sunk and with these a constant check was kept on the lowered water level.

In addition to the wells along both sides of the lock five were sunk between the steel piling cut-off and the face of the inner blockwork dam, and four through the centre section of the outer hardcore dam for the purpose of safeguarding the dams against hydrostatic uplift which would lower the resistance to sliding. In the case of the outer dam,

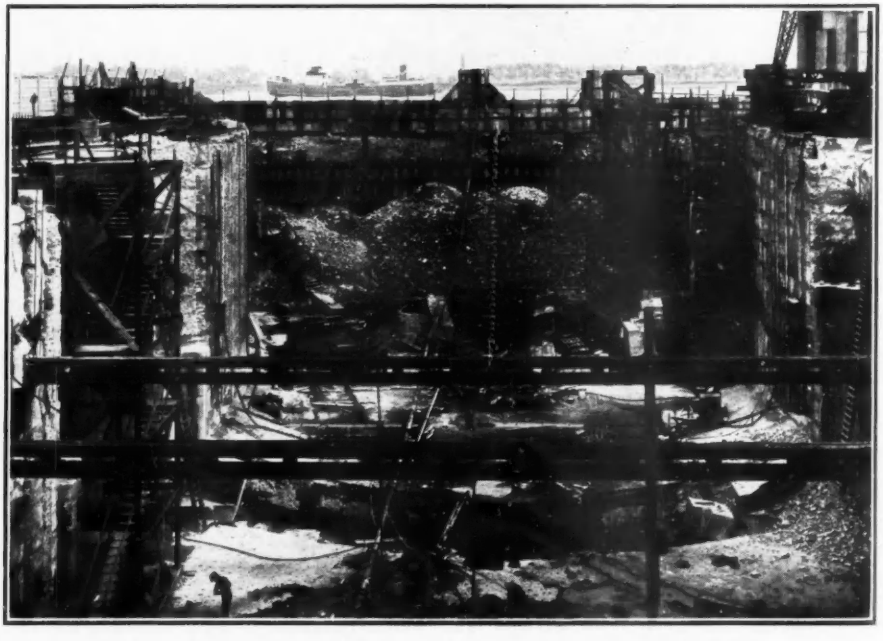
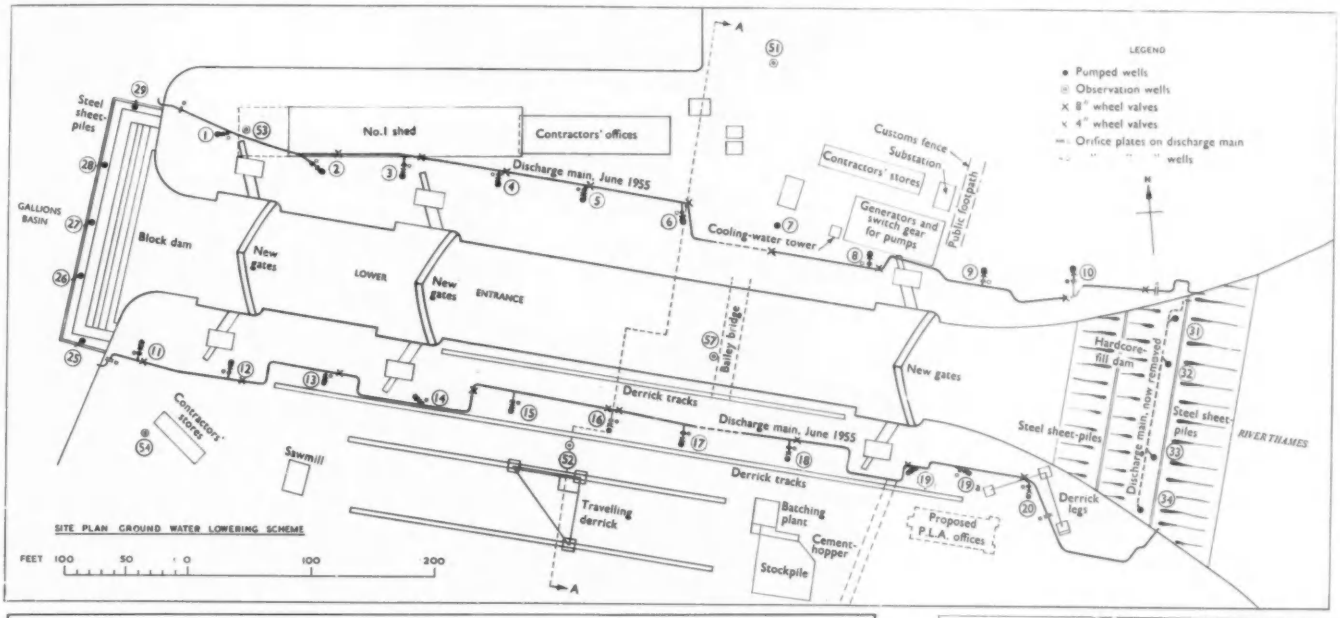
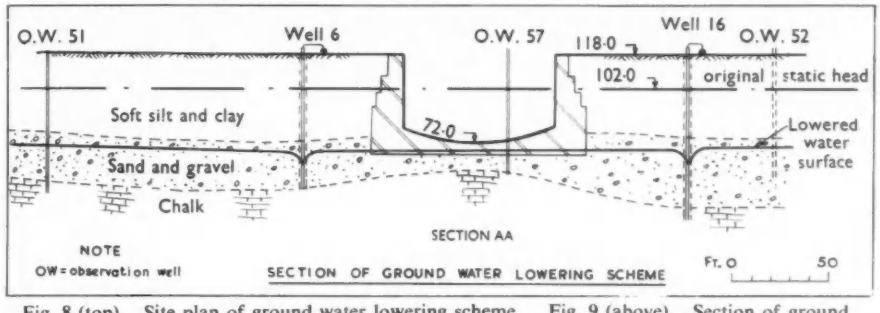


Fig. 7. Outer dam and bellmouth. Note River Thames in background.

Port of London— continued





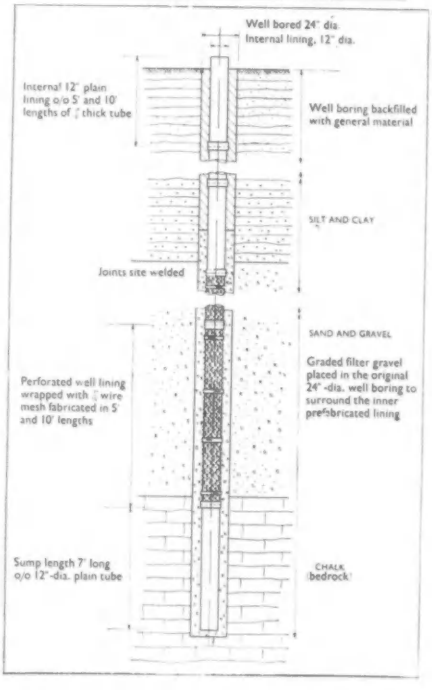

Well bored 24" dia.
Internal lining, 12" dia.
Internal 12" plain lining o/o 5' and 10' lengths of ⅜" thick tube
Well boring backfilled with general material
SILT AND CLAY
Joints site welded
SAND AND GRAVEL
Graded filter gravel placed in the original 24"-dia. well boring to surround the inner prefabricated lining
Perforated well lining wrapped with ⅜" wire mesh fabricated in 5' and 10' lengths
Sump length 7' long o/o 12"-dia. plain tube
CHALK bedrock

Fig. 8 (top). Site plan of ground water lowering scheme. Fig. 9 (above). Section of ground water lowering scheme. Note the artificial ground-water level. Fig. 10 (right). Typical deep well of ground water lowering scheme.

however, it was found that they were unnecessary but those at the inner dam were run continuously.

The well system was very successful and lowered the water level to just below invert level, which rendered surface sumps unnecessary for normal repair work in the lock.

The well pumps were run from the public electricity supply but two standby generators were provided each of 375 KVA capacity, which could take over within a matter of minutes in an emergency. The pump motors were controlled by a process drum-starter which automatically restarted the pumps in sequence after a stoppage due to interruption in the power supply.

(b) Kentledge on Invert.

The specification called for an invert loading of 10 tons per foot run and this was obtained by building a wall of concrete blocks along the centre 13-ft. 6-in. width of the invert. When, however, the deep wells were found to be so successful this loading was reduced to 8 tons per foot run and the blocks thereby released transferred to the inner dam to form an additional course as kentledge. This can be seen in Figs. 3 and 14.

(c) Strutting.

A series of struts, each capable of offering 70 tons resistance, was placed across the lock between the wall faces at 33-ft. intervals.

The struts were made up of two sections of No. 5 Larssen pile separated by 8-in. spacer pieces and welded up into box sections.

Although these struts were in position in the lock for over two years, there was never any evidence that they became loaded by wall movement. The struts are clearly seen in Fig. 3.

8. Improvement of Locking Capacity.

At the time the lock was constructed it was the practice to provide curved inverted arch bottoms and this suited the section of ships of those days. The invert of this lock was constructed to a radius of 110-ft. The cills, however, were level for a width of 52-ft. but rose 4-ft. 6-in. at the sides in comformity with the profile of the curved invert.

The curved haunches of both the invert and the cills were cut out and reconstructed horizontally at the level of the cills and the gate operating chains, which stretched across the lock on both sides of the gate and which had often fouled the bilge keels of ships, were removed. The effective depth of the lock was thus increased by nearly 4-ft.

This is valuable for several reasons:—

(a) it enables deeper draughted ships to be locked;

(b) it increases the effective locking period for ships of lesser draught;

(c) ships with the former maximum draught at spring tides can now be locked on almost any tide.

Sections of the lock, before and after reconstruction are shown in Figs. 4 and 5.

9. Invert Haunches.

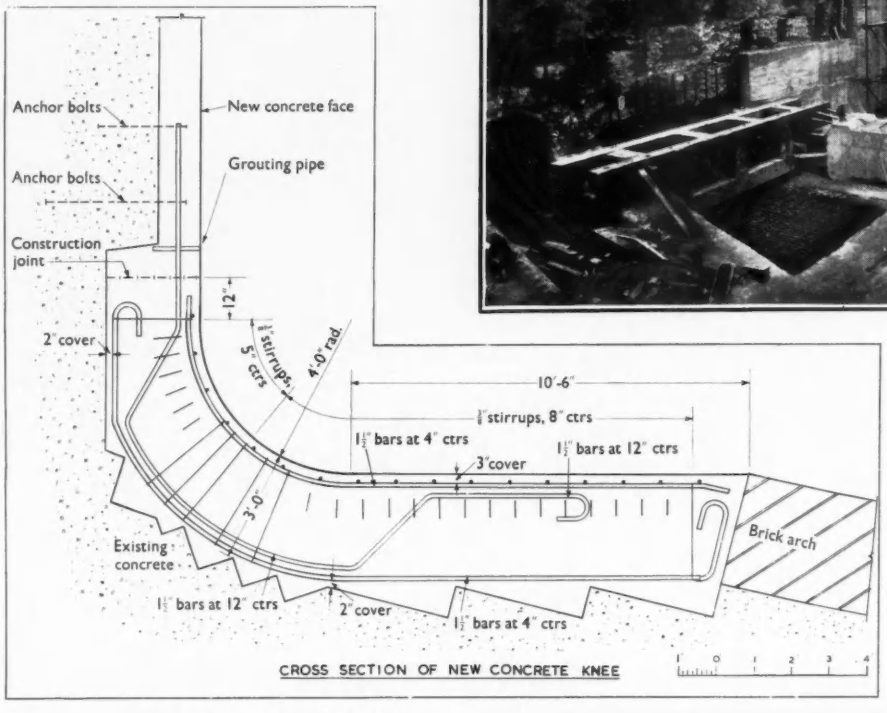
The cutting away of the sides of the curved invert and their replacement by reinforced concrete knees, so designed that their horizontal surfaces gave the desired increase in depth and yet were strong enough to replace the section of invert arch removed, was one of the major features of the reconstruction. Considerable care was necessary in

Port of London—continued

this operation since the excavation partly undermined the lock wall.

Although the lock wall had generally the usual section with a stepped back, at intervals of 55-ft. the section was rectangular, forming a reversed counterfort. A programme was therefore worked out in which no two excavations were closer together than this distance and each was limited to 11-ft. in width.

After various initial experiments the Contractor adopted what proved to be a very satisfactory method of carrying out this work.



CROSS SECTION OF NEW CONCRETE KNEE

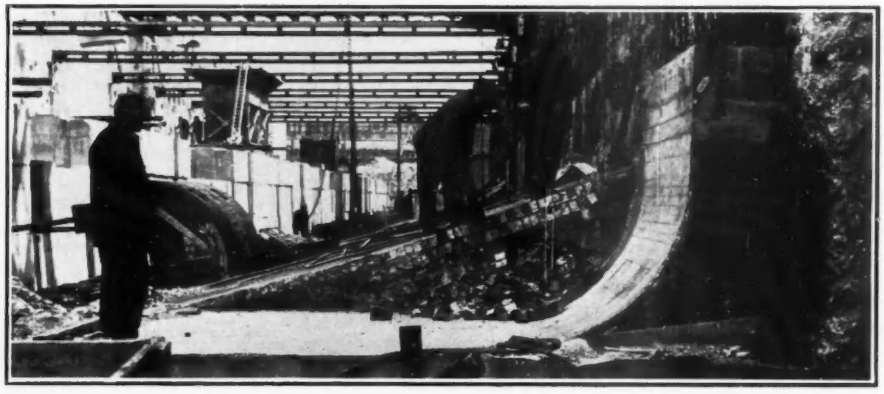
Fig. 11 (left). Cross section of concrete knee. Compare with Fig. 12. Fig. 12 (above). New reinforced concrete knee under construction. Note the 6-ton reinforcement cage and the curved shuttering ready in position for concreting. Fig. 13 (below). New concrete knee with original profile in background. The central concrete mixing plant can be seen which supplied concrete to knee construction work on both sides of the lock.

Slots were made with a "Siskol" mining cutter on three sides of each section which were then in correct turn excavated by twice firing a series of small charges of gelignite and clearing out the debris. Due to the Siskol slots there was negligible shock wave from these explosions. The back and bed of the excavation was then finished to correct profile with pneumatic tools.

The steel reinforcement which weighed 6 tons per 11-ft. length was lowered into each excavation as a completed cage and after the fixing of the necessary shuttering was concreted in one lift to just underneath the thrust shoulder of the wall. (See Figs. 11 and 12.)

After a period of not less than 7 days the concreting of the section continued, this time including a portion of the refacing to about 3-ft. above the shoulder. In this lift a cardboard tube with plugged end was set in the concrete from the shuttering face to 2-in. from the shoulder.

Several months later, after the concrete in the knee had completed its shrinkage, the end of the hole was drilled through to the shoulder, and special non-contracting cement grout pumped in progressively under pressure so that any shrinkage gap under the wall shoulder was effectively filled.



A completed knee with the original profile in the background is shown in Fig. 13.

10. Granite Quoins and Cills.

The granite hollow and square quoins were found to be in far worse condition than had been anticipated. Not only had most of the upper stones been badly damaged by craft but on careful examination it was found that nearly 90 per cent. of all the stones were insecure.

The granite cills were also found to be badly damaged, especially at the apex sections. (See Fig. 14.)

In anticipation of certain of these discoveries new stones had been ordered from the Penryn quarries in Cornwall, from which it was known that the original granite had been supplied, so that the quality and texture would be the same.

Port of London—continued

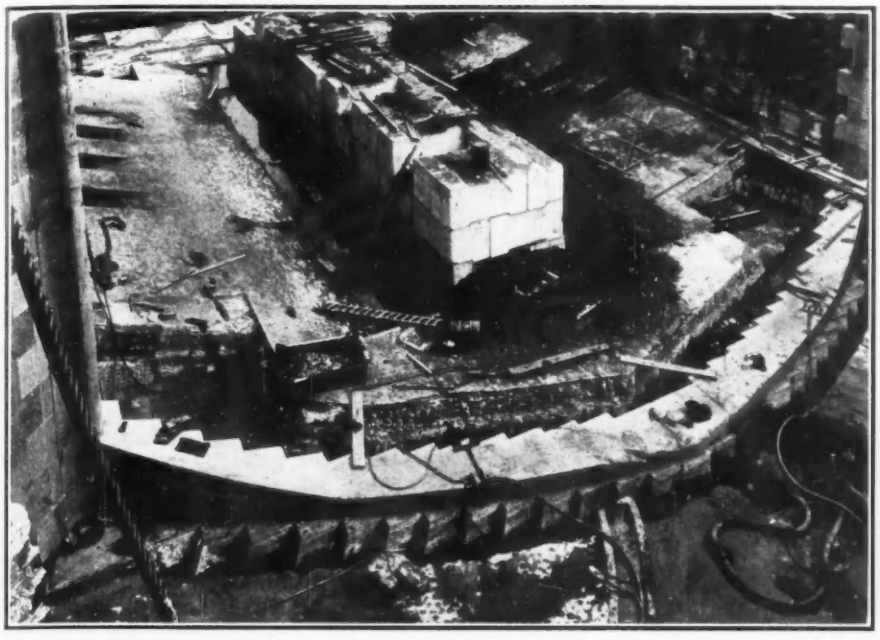


Fig. 14. View of gate cill excavated and ready for removal of granite. Note the damaged and chain grooved stones especially around the apex.

For the repair work the Contractor set up a granite yard on the site to which all stones were taken and reconditioned with the exception of the hollow quoin foundation stone, which was left undisturbed.

The design of the hollow quoins was improved by the addition of two scraper edges to prevent debris being rolled behind the heel post. The cills were also improved by being made both level and straight except at the heel post where a slight crank was unavoidable.

The reconditioning of the stones in the granite yard was complete except on watertight surfaces which were left $\frac{1}{8}$-in. proud. Final dressing of these surfaces was carried out in situ.

11. Culverts.

Three services culverts were originally contained in the invert at the inner end, two of which were 4-ft. in diameter and carried three large sewage pressure mains, and the third, which was slightly larger and mushroom shaped in section, carried various P.L.A. services, a 12-in. gas main and two large high tension cables.

Because of difficulties with maintenance and lack of space for future mains it was decided to:—

(a) reconstruct and enlarge all three culverts;

(b) recondition the existing P.L.A. shafts;

(c) replace the existing L.C.C. shafts by a single 7-ft. 11-in. dia. cast iron lined shaft on each side which would serve both culverts.

The three new culverts were each 6-ft. square, which entailed the reconstruction across the lock of a section measuring approximately 26-ft. wide by 11-ft. deep. Before this could be done two difficulties had to be overcome.

The first was that, as the thrust from the inner dam was taken by the invert structure, any cutting out might cause some risk to the dam and the other was that there would be an undue hydrostatic uplift on the base of the excavation.

The thrust problem was overcome by constructing each culvert in turn in five separate sections, each section being completed before work commenced on the next. By this means, the resistance to the thrust from the dam was maintained throughout the excavation.

The water problem was solved by excavation to about 1-ft. above formation level, and by driving a series of $1\frac{1}{2}$-in. diameter vent pipes which were connected together and run off to a low sump in the adjoining section from where the water was pumped away. By this method the formation level was successfully reached and the new floor and first 3-ft. of the walls concreted in around the pipes. The pipes were then cut off flush with the concrete, grouted up and plugged.

As with the new lock gate dam positions, all longitudinal joints were made radial to ensure arching resistance to hydrostatic uplift. In addition, all joints contained a P.V.C. water seal strip which on test after the lock had been re-flooded was found to be very successful.

The old L.C.C. shafts were cut out to accommodate the 7-ft. 11-in. dia. cast iron tunnel segments which were lowered in position in three ring groups, bolted to the previous work and concreted in position.

To enable all this reconstruction work to be carried out, all the mains had to be removed from the shafts and culverts and certain of them diverted across the inner dam. Before and after reconstruction sections of the culverts can be seen in Fig. 4.

The Southampton Pilotage Service

Wide Range of Duties

By "CLAUSENTUM."

The Port of Southampton is situated within the Trinity House Isle of Wight Pilotage District, the limits of which extend from Selsey Bill to Peveril Point. This District, through which the Southampton Pilots operate and for which they are licensed includes, inside these limits, all waters of the Isle of Wight, both within and without, and all harbours, docks (except Admiralty) and tidal waters therein.

Pilots for the Isle of Wight District have been following their profession for several hundred years and actual records of Pilots can be traced back to the seventeenth century. The establishment of the District by Trinity House, however, did not take place until the year 1808, when George III empowered the Elder Brethren of Trinity House to license Pilots and appoint Sub-Commissioners to act as their local representatives for the newly created District.

It was not until Southampton began to develop with the opening of the Outer Dock in 1842, that Trinity House, realising the future importance of the Port, licensed Pilots for the Port of Southampton. During these early years each Pilot or Pilot family owned and operated their own cutter, which put the Pilot aboard or landed him wherever necessary, and in the year 1822, obviously days of keen competition, there were as many as 38 privately owned Pilot cutters operating in the Isle of Wight District. An original copy bearing the names of Pilots and their cutters, dated 1822, is framed and hung in the present Pilots' Office at 18, Queen's Terrace, Southampton.

Legislation by Act of Parliament, however, during the latter part of the nineteenth century and the early years of this century culminated in the establishment of Pilot cutters at the Eastern and Western extremities of the Isle of Wight, known as the Sea Cutters, and one cutter stationed on the Western side of Southampton Water, one mile seaward of the Docks, known as the Netley or Docking cutter. The Sea Cutters were still privately owned by the local Pilots until 1910, when they were acquired by Trinity House and replaced by auxiliary and more modern vessels under the Trinity House flag and manned by Trinity House personnel. The Netley or Docking Pilot Cutter, however, is still jointly owned and maintained by the Southampton Pilots.

Southampton Pilotage Service—continued

Officially known as "The Isle of Wight Outward Pilot Service," the Southampton Pilots, thirty in number, are responsible for many and varied duties of pilotage, including the pilotage of vessels from Docks to sea, a distance of twenty-four miles either to the East or West extremity of the Isle of Wight; the pilotage and docking of ships inward from the Docking Pilot Cutter at Netley, where one of the several Southampton Pilots who are on docking duty takes charge and relieves the Inward Sea Pilot; the berthing and unberthing of all oil tankers at the "Esso" and "Shell" oil installations, at Fawley and Hamble jetties; all movements inside the Southampton Docks, such as manoeuvring of ships into dry-dock or shifting from one berth to another. Lastly, but by no means the least, constituting as it does quite a large part of their work, is the pilotage up the Rivers Itchen and Test of small craft and colliers to the various coal, timber, and shipbuilding wharves and quays situated on these shallow and tidal berths.

Recruitment to the Southampton Pilot Service is normally from the Inward Sea Pilot Service, by virtue of seniority. The period of service as an Inward Pilot varies from approximately ten to fifteen, according to retirements, etc. It can be seen, therefore, that all the Southampton Pilots have had many years experience of piloting before being transferred from the Inward to Outward Service and to the responsibility of docking ships of all sizes. Both the Southampton and Inward Pilots must, of course, hold a foreign-going Masters' Certificate and have been in command or held senior rank in the Merchant Service or Royal Naval Reserve.

The Pilots are not employed by Trinity House, as is so often thought, but are self-employed, working as a corporate body, administering their own affairs and business. They are, however, under the Authority of and licensed by the Elder Brethren of Trinity House, to whom they are responsible for conduct and the efficient working and maintaining of the Pilot Service. All charges and dues for acts of pilotage and extra services are laid down by Trinity House, whose Authority for the whole Isle of Wight District is vested in a body of Sub-Commissioners with headquarters at Southampton and to whom all matters relating to Pilots and Pilotage must be submitted.

During the last war when Southampton and the whole Isle of Wight District was the principal build-up and assembly point for the invasion of Normandy, the Southampton Pilots had an arduous and difficult task—to keep the ships moving without delay. This, in conditions of black-out, with dimly-lighted channels and buoys almost indiscernible, during bombing and minelaying raids and under conditions which in normal times, no prudent Pilot would entertain, was no mean task. The fact that there never was any appreciable delay speaks for itself. During the whole period of World War II the Southampton Pilots handled approximately 21,000 ships, totalling 55,000,000 tons of shipping.

The Pilots maintain a working system which is agreed mutually amongst themselves. This consists of two sections—Outward Sea Duty and Docking Duty, on a strict roster basis, with all Pilots taking their turn with both duties. Each pilot takes his turn also as Duty Pilot in charge of the Pilots' Office, receiving orders from the various shipping companies and generally directing all movements of Pilots to their various jobs.

Most liner companies employ what is known as an appropriated Pilot to attend to their ships and, by paying a retaining fee, can utilise this particular Pilot's services whenever their ships are moving in or out of the Port. This is sanctioned by Trinity House, with a proviso that such service applies only to vessels of over 12,000 gross tons. The advantages of this is, of course, that the same Pilots are handling the same ships all the time, thus acquiring a knowledge of handling each particular ship and understanding any idiosyncrasies, peculiar to ship handling, of each individual ship belonging to the Company for which the Pilot works.

Correspondence

To the Editor of "The Dock and Harbour Authority."

Dear Sir,

Problems of Increased Temperature in Harbour Waters

As an engineer member of a local group of marine biologists, I was greatly interested in the article entitled, "Problems of Increased Temperatures in Harbour Waters," which was published in the January, 1956 issue of "The Dock and Harbour Authority," and thought that perhaps you might be interested in the work both of our local Council, and that of the Harbour Pollution Control Committee of the State of California Regional Water Pollution Control Board No. 4.

The Port of Los Angeles, California, is an artificially constructed port, almost totally enclosed by land. At the north-easterly end of the harbour there is a storm channel, shown on the map as Dominguez Channel, which carries storm waters in season and industrial waste from oil refineries and other industrial operations throughout the entire year. This has produced a water pollution problem within the harbour, insofar as the use of harbour waters for cooling, recreation, etc., is concerned, which, in turn, has caused the State and local authorities to set up water criteria limitations with regard to the several types of pollution.

A committee was formed several years ago whose duties, in part, consist of policing these waters by means of routine monthly sampling and testing. They make the following examinations, taken at two elevations in the water column:

Dissolved oxygen Temperature Floating solids
Sulfides Odour Colour Oil

Water transparencies were measured with a standard Secchi Disk.

During the past decade a routine monthly survey has been conducted on the quality of water in the combined Los Angeles—Long Beach Harbours, based on some twenty to thirty sample stations. Results of this survey are a public record and can be made available for distribution to interested parties.

About five years ago an unofficial group of marine biologists banded together, to form the organization, the "Southern California Marine Borer Council," and made a "biological survey" of the harbour under the direction of Dr. John Mohr of the University of Southern California. A large portion of this survey was devoted to the distribution of marine borers in polluted and unpolluted areas of the harbour. An extensive report is in process of preparation as a result of the survey, and can be made available to all interested parties at their request.

Our findings are available to your readers and we, in turn, would like to receive from Port Authorities and others further details or references to any studies such as those made by Prof. J. E. G. Raymont of the Department of Zoology, University of Southampton, with regard to the temperature effect on marine borers, particularly **Limnoria.**

Yours very truly,
C. M. WAKEMAN
Secretary.

Southern California Marine Borer Council
Los Angeles Harbour Department,
Wilmington, California, U.S.A.
10th April, 1956.

Publication Received

"Tide, Speed and Distance Tables for 1956." Published by Kelvin and Hughes (Marine), Ltd.

This publication contains additional information on dock and harbour facilities, and there is an extended and revised general tide table. The data given for tidal predictions at Glasgow, Greenock, London Bridge, Liverpool, Belfast and the River Tyne are copyright by the Liverpool Observatory and Tidal Institute, and those for Cardiff and Dover, Crown copyright. Tidal predictions for Hull are also based on Crown copyright material, all of which is supplied by the Liverpool Observtaory with permission of the Controller, H.M. Stationery Office and Hydrographer of the Navy.

The tables are printed in handy pocket size and other useful data relate to stowage factors, rope strengths, standard times, in addition to Kelvin and Hughes depot addresses, and drydocking facilities in British ports. This is the 58th year of publication of the tables.

Rebuilding of No. 6 Transit Shed at Port of Bremen

Dual Purpose Shed for Fruit and General Cargo

By Oberbaurat Dipl. Ing. HELMUT JUNG, Bremen.

Development of the Project

DURING the war and in the years immediately after the war the import of fruit into Germany was at an almost complete standstill. Since about 1949/1950, however, the volume of imports of tropical fruit has shown a considerable increase, as is evident from the following figures:

	Citrus fruits (oranges, lemons, etc.) tons	Grapes (currants, raisins, etc.) tons	Total tons
Average of the years 1912-1914 ...	9,400 (approx.)	2,140 (approx.)	11,500 (approx.)
Average of the years 1935-1938 ...	22,300 (approx.)	8,600 (approx.)	25,350 (approx.)
1950	7,024	6,024	13,048
1951	9,388	1,705	11,093
1952	15,593	4,693	20,286
1953	28,064	4,010	32,074
1954	23,026*	4,448	27,474

*The lower tonnage in 1954 was due to the poor crop yielded by the Spanish plantations. The above figures do not include banana imports handled at Bremerhaven.

Whereas special installations for the unloading of bananas have been provided in many of the larger seaports, oranges, lemons, grapes, etc. can in general be handled and stored in ordinary sheds, except that it is necessary to equip them with heating appliances in order to protect the fruit against the effects of frost.

With the increase in the volume of fruit imports at Bremen after the war, improvised facilities for the handling of fruit were created in a section of No. 15 shed in the "Oversea Dock" to replace the fruit shed which had existed in the "Europe Dock" before the war and which had been totally destroyed. This arrangement was of an improvised character in that it consisted of an ordinary general-cargo transit shed which was provided with the simplest form of heating equipment. Cold air, heated by coke-fired furnaces was forced by means of a fan through light-gauge sheet metal pipes laid under the floor and distributed uniformly inside the shed. Generally speaking, this temporary solution enabled the considerable quantities of fruit imported through the port of Bremen to be handled satisfactorily during a period of three years. During very cold weather, additional heating to meet "peak" requirements was provided by a locomotive of the German Railways which was stationed behind the shed for the purpose. Apart from this improvised and uneconomical solution, there was a further disadvantage in that the handling of fruit went on in the midst of the general cargo-handling operations at the deep-water berths (intended for large sea-going vessels of 30-ft. draught) in front of sheds No. 13, 15 and 17. This added to the difficulty of operating the port, as, particularly in the case of tropical fruits, the motor lorry was almost the only form of transport used for conveying it inland. Having regard to the restricted amount of space afforded by the port installations, this heavy lorry traffic caused overloading of the road facilities, which could not be tolerated in the long run.

In planning a fruit transit shed, the need for which was becoming increasingly urgent, it was decided to equip No. 6 shed in the "Europe Dock" as a shed for the handling of fruit (Fig. 1). The construction of a fruit shed on a quay generally means unfavourable utilisation of the latter, as the fruit ships arrive only during a certain limited season and only at irregular intervals, while successive arrivals tend to be separated by fairly long intervals of time. It was considered that the best way to bridge these gaps in quay operation was by providing additional storage space over the fruit shed in order to be able to deal with general cargo at this quay in such slack periods during the fruit season. Basically, therefore, the upper storey is used permanently for general cargo handling; on the ground floor, section C is permanently reserved for fruit, whilst sections A and B are used, as required, for fruit during the fruit season and for general cargo at other times.

Design Considerations

No. 6 shed has a length of approximately 300 m. and a width of 36.50 m. (Figs. 2 and 3). Owing to the railway installations located behind the shed it was not possible to adopt a greater shed width.

In order to make the best possible use of the existing quay on the south side of the "Europe Dock," it was decided to build a two-storey transit shed instead of providing the usual single-storey type of shed.

To enable cranes to travel along the full length of the quay on the south side of the "Europe Dock" and to make them interchangeable with the cranes of other docks in the port, the standard type of crane adopted for No. 6 shed was the semi-portal crane with an overhead duct for the electrical contact wire.

This uniformity of crane track gauge, elevated crane track construction and contact wire arrangement also presents an advantage from the point of view of operation in that the contact wire duct provides the crane operatives with a safe access walkway to the various cranes. These constructional requirements, which were determined by the existing crane design, were well suited to the provision of side glazing over a sufficiently great height to ensure good daylighting of the interior of the shed. Even if a different crane track design or a different arrangement of the contact wire duct had conceivably been adopted, a lower construction height for the shed would have been undesirable in view of the need for providing adequate daylighting. The foregoing considerations determined the leading dimensions of No. 6 shed.

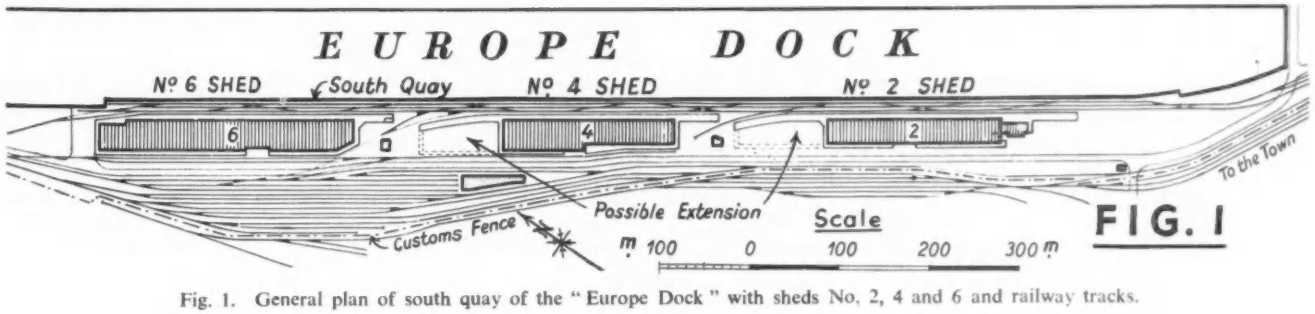


Fig. 1. General plan of south quay of the "Europe Dock" with sheds No. 2, 4 and 6 and railway tracks.

Rebuilding Transit Shed—continued

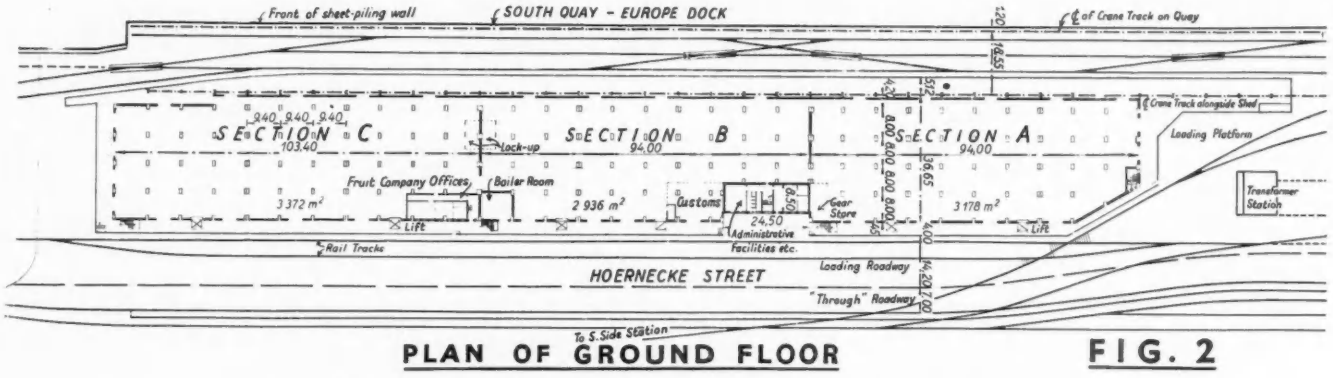


Fig. 2. No. 6 shed: ground floor plan with road and rail facilities at rear and on water side.

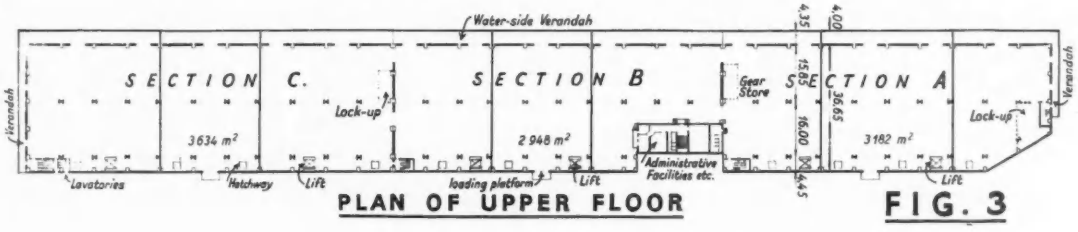


Fig. 3. No. 6 shed: upper floor plan.

Cross-section of the Shed

The particular form of construction adopted for the cross-section of the shed on the water side was determined by the following circumstances and requirements (Fig. 4):

(a) The approximately 1.60 m. rearward projection of the contact wire duct beyond the plane of the centre line of the overhead crane track.

(b) The requirement of a minimum passageway of 2.80 m. between the first row of crane supports and the side of the shed on the ground floor.

(c) The consideration that a width of about 4 m. for the upper-storey verandah, which is provided with a solid concrete parapet, is adequate for enabling loads to be dumped safely upon it.

The cross-section adopted at the rear of the shed was determined by a series of other requirements, namely:

(a) In a transit shed for fruit it is desirable to have as few doorways as possible, so as to reduce to a minimum the number of openings through which cold air will inevitably enter the shed during the handling of the goods. From the point of view of handling, however, fewer doors mean providing a wider loading platform in order to ensure unhindered traffic of goods from the door openings to the vehicles standing alongside the platform. For this reason a width of about 4 m., instead of the usual 2 m., was chosen for the rear platform.

(b) The diverse character of the goods handled, namely, fruit on the ground floor and general cargo on the upper floor, makes it absolutely essential to be able to operate the two floors separately—e.g., while the fruit section of the ground floor is kept closed—and yet to permit a smooth flow of goods to and from the upper floor. This need for separating the operation of the two floors determined the arrangement of the goods lifts, which convey their loads directly down to the rear platform. It furthermore determined the positions of the cargo hatchways in the floor of the upper storey; these hatchways must likewise enable goods to be lowered directly on to the loading platform quite independently of the fruit shed. The desirability of constructing the shed in accordance with the above considerations was further increased by the need for providing the maximum amount of storage space on the upper floor, which led to a width of 4 m. being adopted for the rearward cantilevering projection of the upper storey.

Whereas the above-mentioned conditions were determined by the constructional features of the crane track and the particular requirements of shed operation on the water side and at the rear, the question as to what type of structural solution to adopt for the load-bearing framework of the shed as a whole was more an engineering problem.

In constructing the crane track in front of No. 6 shed, a stanchion and column spacing of 9.40 m. was adopted in the longitudinal direction of the shed. This spacing was the same as that employed in No. 4 shed and was determined by the requirement of having to locate the new footings in between the foundations of the destroyed old shed, which dated from the years 1888—1896. By adopting this spacing it was possible to re-use the crane track that had belonged to the old sheds No. 8 and 10, which had likewise been destroyed. After undergoing slight repairs and modifications, this crane track, which was still in tolerably good condition and which consisted of an I P55 rolled steel I-section joist with a crane rail riveted to it, was for the most part used again for reasons of economy.

With regard to the transverse direction, various possible arrangements were investigated in the preliminary design stage, namely, portal frames having 5, 4 or 3 columns. As the cost of a structure increases considerably for an increasing length of span, it was necessary to go into this question very carefully in order to weigh the resultant cost against the requirements of the building. In the case of a shed meant purely for general cargo, the decision would have been for four, or perhaps even only three columns, as the handling of general cargo calls for the maximum amount of unobstructed floor space. The ground floor of No. 6 shed has, however, been designed primarily for the handling of fruit—a requirement which is unlikely to change. A characteristic feature of fruit handling is the great diversity in the kinds of fruit that have to be dealt with, each of which has to be stored separately, so that a large number of stacks of varying size are formed. The presence of columns in between these stacks does not interfere with the satisfactory operation of the shed. In view of the ease of handling afforded by the fruit crates, a lay-out incorporating five columns in the transverse direction was therefore not considered to

Rebuilding Transit Shed—continued

present any undue amount of obstruction. Tenders were invited on a design based on portal frames with five columns, the tendering firms being given the option of submitting an alternative scheme with a smaller number of columns. From the tenders received it was apparent that the extra cost for a structure with fewer columns would be of the order of 160,000 DM. Although this represents only about 4 per cent. of the total cost of construction, the scheme with five columns was nevertheless adopted for the reasons set forth above.

General Description of the Building Plan

The following general description is to be regarded as supplementary comment on the illustrations.

At gable end "A" the corner of the shed had to be cut away at an angle in order to provide suitable rail access to the quay from the railway station situated farther back (Fig. 2 and 8).

Administrative and other Facilities

In the central section of the shed, accommodation is provided for general administrative purposes and comprises office space for the "Bremer Lagerhaus-Gesellschaft" (Bremen Warehouse Company) and customs accommodation, as well as changing and washing facilities, equipped with shower baths, for the dockers.

While all operations in connection with general cargo traffic in the shed are directed from this point, separate office accommodation with appropriate staff facilities is provided in section C, in which fruit is handled and which is permanently reserved for the use of "Fruchthandels-Gesellschaft" (Fruit Trading Company), who control this branch of activities. In order to save valuable floor space in the shed, the staff facilities are accommodated on a mezzanine floor.

Verandah on Water Side of Upper Floor

The verandah on the water side of the upper floor is provided with a 75 cm. high solid reinforced concrete parapet surmounted by a timber capping beam which serves to protect the concrete as well as any crane load hitting it. The following considerations led to the adoption of a solid parapet wall:

Movable railings, tubular posts with chains, etc. are, admittedly, in general use for this purpose and are moreover required as the minimum safeguard against accidents in cases where men have to work at some considerable height above ground. In two- and multi-storey sheds in other countries, however, a low kerb beam has often been considered sufficient. The solid parapet has the advantage that, for instance, a truck coming out of the shed on to the verandah cannot come crashing down in the event of brake failure, and furthermore that goods stacked on the platform of a truck are likewise prevented from falling down if they slide off the platform due to sudden application of the brakes. This high parapet is better than other constructions in providing protection for trucks and their loads. From the structural point of view this parapet wall has the advantage of providing a good edge stiffening beam for the cantilevered slab.

The verandah on the water side of the upper floor is 4 m. wide and is continued with a width of 2 m. along the two gable ends. These verandahs along the ends of the building can, for instance, be served by a mobile crane and can suitably be used in conjunction with mobile chutes; their main purpose, however, is to provide, in compliance with fire safety regulations, an uninterrupted line of escape from the upper floor to the staircases situated at the rear corners of the shed.

Building Materials. Method of Construction

In the choice of building materials, the determining factor was that reinforced concrete was the only suitable material for all the structural features of the lower storey, as a high degree of humidity of the air would have to be reckoned with on account of the heating and the high moisture content of the fruit. Experience has shown that a steel structure entails considerable additional cost for ensuring satisfactory protection against corrosion of the members or, alternatively, calls for continual and expensive maintenance. Comparative estimates of the cost showed reinforced concrete to be the more economical material in the present case.

The foundations are constructed in concrete of B 225 and B 300 quality, B 300 concrete being used for the columns, beams and floor slab.* A wetting agent was used in making the concrete and internal irbrators were employed in the construction of all the structural members. The columns and the heavy main beams of the structural frame were concreted in situ, whereas the secondary beams spanning between the portals were precast members, which were connected monolithically to the main beams and the floor slab when these were poured in situ.

The size and weight of the precast members employed, which

*B 225 and B 300 denote the quality of the concrete; the values indicate the cube strength in kg/cm² at 28 days.

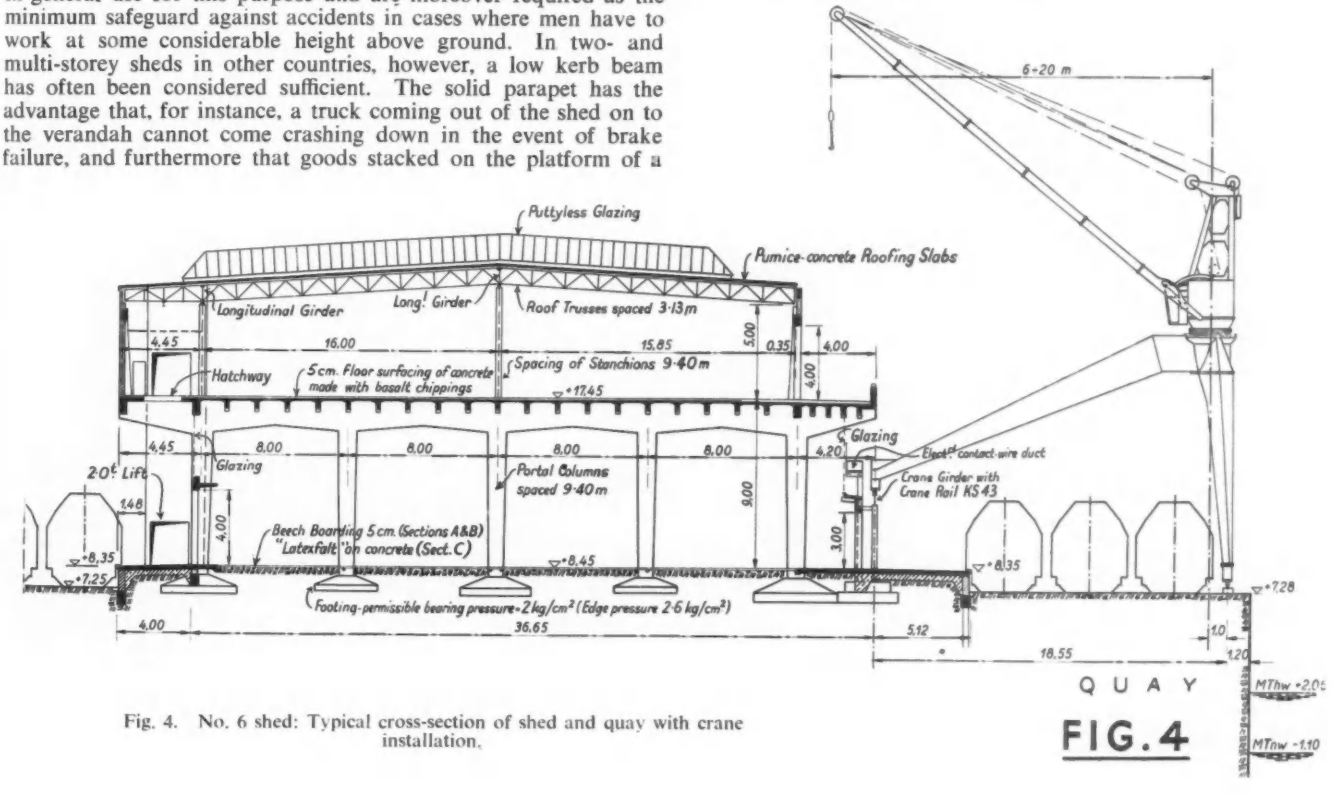


Fig. 4. No. 6 shed: Typical cross-section of shed and quay with crane installation.

FIG. 4

Rebuilding Transit Shed—continued

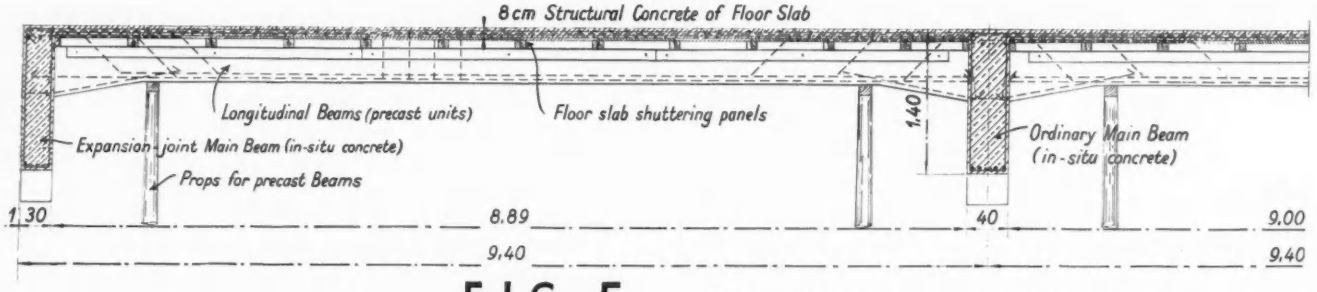


FIG. 5

Fig. 5. Construction method used for upper floor, incorporating precast concrete beams.

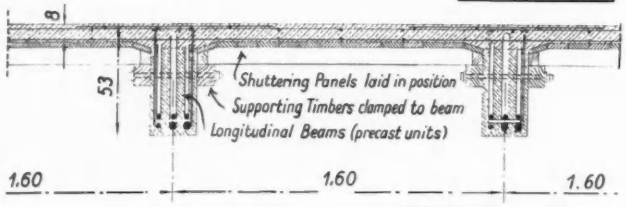


FIG. 6

Fig. 6. Method of connecting floor slab shuttering to the precast beams.

were likewise made of B 300 concrete, were limited by the lifting capacity of the tower cranes used for the erection of the building by the contractors. This factor determined the beam spacing of 1.60 m. and the small depth of the slab (8 cm.) spanning between the beams (Fig. 5 and 6).

The shuttering for the floor slab was made up into prefabricated panels and was supported on timbers bolted to the concrete beams. By the adoption of this procedure a good deal of labour and material was saved in erecting the shuttering; this was an important consideration, since the slab was 9-in. above ground floor level and would have necessitated the use of excessively long props.

The wall framework of the upper storey was also constructed in reinforced concrete. The roof construction with its internal stanchions and trusses is a lightweight steel structure, steel having shown itself to be the more economical material for this part of the building. The roof trusses are welded lattice girders. There are no purlins: the pumice concrete lightweight roofing slabs, which weigh 80 kg/m² (16.3 lb./sq. ft.) and have a span of 3.13 m., are carried directly by the trusses. From the constructional point of view it should be noted that, in order to reduce the cantilever moment in the horizontal member of the reinforced concrete portal frame, the rear wall of the upper storey takes no horizontal or vertical load from the roof and has been constructed as a detached wall fixed to the portal frame.

Expansion Joints. Sealing Methods

As the building has an overall length of about 300 m., it was, of course, necessary to divide it up into separate units by providing expansion joints. Every three or four bays of 9.40 m., i.e., at intervals of 28.20 m. or 37.60 m., a 20 mm. wide continuous joint goes transversely through the whole building from the top of the foundation to the roof structure. This joint was formed in the structural concrete by inserting 20 mm. thick slabs of pressed peat, which were subsequently removed with the aid of coarse-tooth saws after the adjacent concrete had hardened. This method of forming the joints was, admittedly, more expensive than using corrugated cardboard or similar materials, but ensured that the requisite joint width of 20 mm. was indeed obtained. Where necessary, the vertical joints were afterwards sealed with tarred rope in conjunction with an elastic sealing compound. The horizontal joints in the floor slab of the upper storey, both on the verandah and inside the sheds, are provided with copper expansion joint strips of the usual type.

Roof-lights. Side Wall Glazing

The saddle type roof-lights of the upper storey as well as the side wall glazing of the ground floor consist of a puttyless system of glazing. The problem of ensuring adequate natural lighting of the ground floor was exhaustively studied. In order to improve the daylighting conditions, the interior of the shed was kept as light as possible by the application of a white limewash. The fixed side wall glazing of the ground floor is provided in each bay with a casement for ventilation purposes, but otherwise consists of simple 7 to 8 mm. thick wired glass glazing.

Thermal Insulation

No special precautions were taken for providing thermal insulation in the glazing nor in any other parts of the structure, such as the outer walls and the 2.5 mm. thick steel single doors. The decision to dispense with any form of thermal insulation was based on the following considerations:

(a) The heat losses through the walls are insignificant in comparison with the loss of heat caused by the open doors, for which the heating installation had to be designed.

(b) Experience has shown that in most years the need for heating the shed is limited to a relatively small number of days and that it is therefore more economical to keep the construction cost of the building low and to compensate the loss of heat due to imperfect thermal insulation by increasing the output of the amply designed boiler installation when necessary.

Special Constructional Features

A number of special features had to be introduced in the construction of No. 6 shed, as distinct from a single-storey shed. These were partly due to the two-storey form of the building and partly to the fact that it had to be suitable for the storage of fruit. The frequently heard criticism of two-storey sheds is levelled not only

Fig. 7. No. 6 shed: Water-side elevation, showing the new cranes on the south quay.

Rebuilding Transit Shed—continued

Fig. 8. View on gable end "A" and rear side of shed.

against the undoubtedly higher operating costs resulting from having to work on two separate floors, but is also aimed at difficulties arising from congestion of the transport facilities, especially during the all-important rush periods. If goods cannot be conveyed to the upper floor quickly enough, or if the despatch of goods from the shed is unable to operate smoothly in consequence of overloading of the hoisting and transporting equipment, then all the means of conveyance dependent thereon—sea-going ships, railway wagons and lorries—will be affected by the delay.

The following measures were adopted with a view to ensuring smooth cargo-handling operations:

(a) For the transport of goods on the water side, modern new travelling cranes of 3 tons lifting capacity and 20.5 to 6 m. radius are available. It is not necessary, for a two-storey transit shed, to increase the number of cranes as compared with a single-storey shed. The appreciably better utilisation of the cranes in the case of the two-storey shed is an advantage.

The number of working hours per crane is greatly increased owing to the larger shed floor area served by each crane and, in cases where the areas of the upper and lower floors are equal (as in No. 6 shed), this means a 100 per cent. increase in utilisation of the crane and therefore much more profitable operation of this expensive piece of equipment.

In conveying goods from the ship to the shed, it makes no difference to the crane whether they have to be stored on the ground floor or on the upper floor, the difference in height being of no consequence. All transport on the water side of the shed, whether upward or downward, is therefore effected by the quay cranes.

As regards horizontal transport in the shed, it makes no difference whether such transport is carried out on the ground floor or on the upper floor, except that the permissible loading on the upper floor must not exceed 1,500 kg/m².

Various possibilities are available for the handling of goods at the rear of the shed (Fig. 9):

(a) Goods lifts, two to each section of shed, i.e., six for the whole building. Each lift serves an area of about 1,500 m² on the upper floor, which compares favourably with the corresponding figure for other two- or multi-storey sheds. The lifts have a capacity of 2,000 kg., which was considered adequate. The internal dimensions of the lift cage are 2.00 x 3.00 m. and are large enough to accommodate the loaded trailer of an electric truck, so that the handling of goods is greatly speeded up, as the time-consuming operations of loading and unloading the lift cage are thereby avoided. The lifts, which are of normal standard design, are equipped for control both from inside the lift and from outside. The driving mechanism is installed in the head of the light frame. The lifting height is 9.0 m., the speed being 0.4 m/sec.

(b) Special winches are provided at the 2 x 2 m. hatchways in the upper floor. These serve to relieve the lifts during rush periods and are available as standby capacity in the event of failure of one of the lifts.

(c) A further means of transport, though only in the downward direction, is provided by chutes, which are particularly suited for loading goods—especially small packages—directly on to lorries.

(d) A fourth means of transport is provided at the back of the upper storey by projecting balconies 2 x 5 m. in size, which are, for instance, suitable for the handling of goods with the aid of mobile cranes.

As stated at the beginning of this article all the cargo-handling devices at the rear are so arranged that the ground floor fruit shed can remain closed and unrestricted operation of the upper floor is yet possible. The need for providing sufficient working space on the ground floor for the lifts, winches and chutes led to the choice of a 4 m. wide rear loading platform, as has already been explained. This platform therefore does not merely deal with ground floor goods traffic, but also serves as working space for the handling of goods dealt with on the upper floor.

Heating Installation

Whereas the nature of the equipment described in the foregoing sections was determined by the two-storey character of the shed, the following installations have been provided especially for dealing with fruit. It should be borne in mind that section C of the shed is reserved permanently, i.e., all the year round, for the transit handling of fruit, while ground floor sections A and B are used for fruit as and when necessary. In designing the heating installation it was therefore necessary to allow for the fact that either one, two or three sections of the shed would have to be heated. A number of assumptions had to be made for designing the heating installation. It has already been mentioned that no thermal insulating material of any kind was used in the construction of the building. It was considered adequate to design the heating equipment for a temperature difference of 20°C., i.e., that it should be possible to maintain a temperature of +5°C. inside the shed when the outside temperature is −15°C. The heat requirement is about 800,000 Heat Units per hour (approximately 3,150,000 B.T.U. per hour) for 50 per cent. of the doorway area on the water side opened—which is exposed to the cold east wind in winter—and is supplied by a low-pressure steam heating plant. Around these water-side doors heating units are installed which are combined with ventilating equipment and are designed for the following possible conditions of operation (Fig. 10):

(1) Cold fresh air is drawn in on the water side, heated, and introduced through the ducts of the 'hot air portals" so as to throw

Fig. 9. View of the shed (section A) from the rear, showing staircases to upper floor lifts, and loading balcony slab projecting from upper storey.

Rebuilding Transit Shed—continued

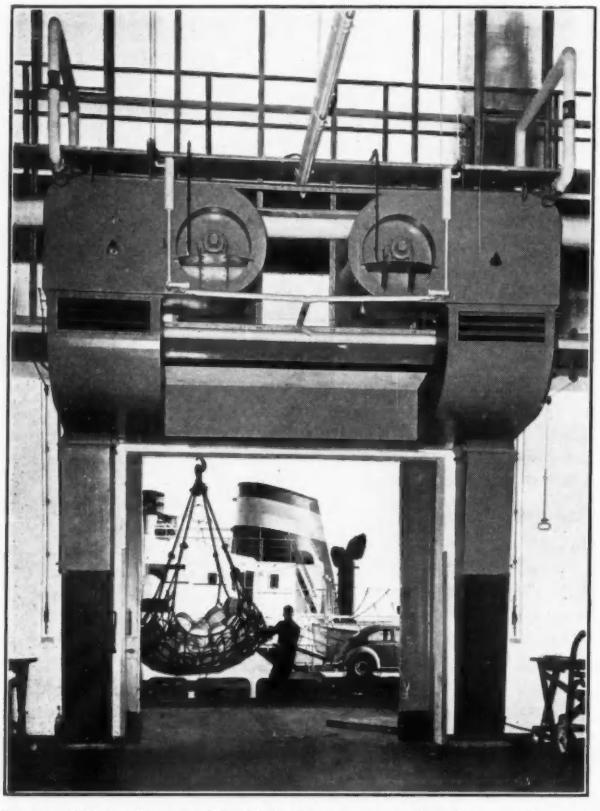


Fig. 10. "Hot-air portal," which throws a curtain of warm air across a water-side doorway.

a curtain of warm air across the doorways.

(2) Heated fresh air can also be blown directly into shed in addition to that introduced by way of the hot air portals.

(3) Air from within the shed is heated on the recirculation principle by the heating units mentioned under (1) and (2).

(4) In summer, the installation can be used for ventilation.

The heating and ventilation units at the rear of the shed are similar to those on the water side, except that there are no hot air portals. There is no need to provide a curtain of warm air at the rear doorways, as the west and north-west winds are not so cold as the east winds and therefore cause less loss of heat. The boiler room is equipped with two oil-fired boilers, each having a heating surface of 125 m². The installation is operated with a steam pressure of 0.2 atmospheres (absolute pressure) and is provided with automatic regulation.

Macerator

For the destruction of fruit which has gone bad, a macerator with a capacity of 2.5 tons per hour is required. The waste matter is discharged through a channel under the floor into the general sewerage system of the dock.

The dilution is 1 part of fruit to 3 parts of water.

Lighting and Illumination

The provision of adequate daylighting has already been referred to. The question of artificial lighting for the shed formed the subject of careful consideration and comparative investigations. The fact that, during the fruit season, the goods stored on the ground floor of No. 6 shed—chiefly oranges—have to be carefully inspected and classified, makes very high demands upon the efficiency of the lighting. Low-tension fluorescent lighting, which is economical in use and gives a light which blends well with daylight, was obviously the correct type of illumination to use here.†

Continuous strip lighting is mounted at a height of 5 m. in a sheet metal housing which also serves as a duct for the cable. The arrangement of the tubular lighting strips at right angles to the longitudinal axis of the shed was determined by the requirements of transporting goods from the verandah into the shed and by the need for wiring and switching the lights in groups in this direction. The ground floor is equipped with low-tension fluorescent lamps of 40 watts each, giving an average horizontal intensity of illumination of about 60 lux and great uniformity. This highly desirable uniformity of illumination is achieved mainly by the fact that the exposed lamps can radiate their light freely, which is reflected by the white-coloured ceilings and walls (Fig. 11).

The upper storey, which is purely a shed for general cargo (Fig. 12), does not require such high-quality illumination, and electric bulb lighting of the usual type has therefore been installed.

Fire-fighting Appliances and Fire Alarm Equipment

The fire-fighting appliances and alarm devices comply with the port fire brigade requirements as regards the number and arrangement of the hydrants on both floors, hand extinguishers and alarm boxes.

Like the vertical goods handling equipment, the staircases giving access to the upper floor have been kept independent of the operation of the ground floor. These stairs are either installed at a corner of the shed, as at gable end "A," or rise as free flights of steps from the rear platform and go up to roof level. In the event of fire breaking out, this arrangement will make it easier to fight a fire in the upper storey.

Cost of Construction

Having regard to the prevailing reluctance to build two-storey transit sheds, the high cost of construction tends to be an obstacle to the provision of the necessary funds. As calculated at present-day prices, the overall cost inclusive of office accommodation and staff facilities, is about 4,400,000 DM, which figure comprises all structural and accessory work, but does not include the mechanical and electrical equipment, nor the laying of railway tracks, paving, drainage and sewerage works, etc.

With reference to the operational capacity of the building, as illustrated by the accompanying diagrams and photographs and explained in the foregoing description, this means a unit price of about 436 DM per square metre of area occupied by the shed (based on the external ground floor dimensions), and a unit price of 228 DM per square metre of utilisable storage space, which totals 19,252 m² (based on the internal dimensions of the two floors).

Taking into account the particular conditions with regard to the rebuilding of No. 6 shed, the above figures may be of interest as guiding data for similar projects; they will at any rate provide a

Fig. 11. Interior view of ground floor, looking towards water side of shed and showing the "hot-air portals."

† See: "Hansa" No. 20/21, 1955, Bötz: "Neue Beleuchtungsanlagen in den bremischen Häfen" (new lighting installations in the Bremen docks).

Rebuilding Transit Shed—continued

Fig. 12. Interior view of upper storey.

means of arriving at approximate estimates of cost for future designs.

Summary

No. 6 shed at Bremen's "Europe Dock" is the first large two-storey transit shed to be built at a German seaport. The character of the building described in the present article was determined by considerations of space available in this port, which was constructed 70 years ago, and by the special requirement of providing facilities for handling fruit and general cargo at one and the same time.

The design and construction of the shed were under the control of the Bremen Harbour Board of Works in close association with the "Bremer Lagerhaus-Gesellschaft" (Bremen Warehouse Company) as the operating company whose task it will be to prove the economic efficiency of this type of shed, which is new to German seaports.

The technical experience with regard to present-day design of two-storey transit sheds for general cargo, which was gained in the course of several study tours of foreign ports, was applied to advantage in the preparation of this project.

Sections A and B of the shed were already put into service at the end of 1954, and section C was completed in the autumn of 1955.

East African Harbours

Report for 1955 and Future Developments

Further improvements have recently been carried out in the major East African harbours and, despite some setbacks, tonnages and revenue in 1955 showed increases over the previous year. Figures published in the Annual Report of the East African Railways and Harbour Administration show that 4,613,000 harbour tons were handled in 1955 compared to 3,992,000 tons in 1954 and that revenue was increased from £2,939,000 to £3,923,000.

The improvement in port revenue was disproportionately more than the increase in tonnage because of tariff increases in export and handling charges which were introduced in March, 1955.

Of the five main ports, Mombasa, Dar es Salaam, Tanga and Mtwara showed profits and only Lindi had a decrease in traffic.

Operating costs (including renewal charges) went up by £610,000 to the high figure of £3,249,000, due almost entirely to higher labour costs, especially for the handling of cargo by the contractors. The figures for 1955 and the developments in each port are as follows.

Mombasa.

Mombasa is the principal port of entry for both Kenya and Uganda and the economic life of these territories is dependent upon the import and export traffic passing through this deep water harbour. During 1955, 3,147,000 harbour tons were handled at the port, an increase of over 300,000 tons over 1954, and revenue rose from £2,024,000 to £2,642,000.

At the beginning of 1955 it was unfortunately found necessary to restrict imports by means of phasing in relation to the assessed capacity of the port, but throughout the year there was a gradual increase in phased tonnage of general cargo imports and the overall figures for the year showed an increase of 16.7% over 1954.

Facilities at the port, both for the reception of ships and the handling and storage of cargo, are being increased to cope with the rapidly expanding economy of East Africa.

Towards the end of 1954, seven deep water berths were in operation and construction work on two others was nearing completion, but in December of that year a movement of the sea bed caused a large part of the piling of one of the new berths (Berth No. 9) to collapse, with serious interruption to the work on the other. Extensive investigations were carried out to see whether the berth could still be constructed on the same site and whether the adjoining berth was safe, and following these investigations it was possible to open Berth No. 8 in June, 1955, although without adequate transit shed facilities and with no cranes. The conveyor from the high level storage sheds at Magadi was brought into use at this berth, which deals mainly with soda exports. Berth No. 9 is to be constructed in its present position at a total additional cost of £600,000 and it is anticipated that it will be available towards the end of 1957. Site investigations have been carried out at Kipevu and two new berths are to be constructed here at a cost of £4,000,000 and will be available by 1958/60.

The possibility of providing passenger handling facilities at the port by means of a light form of deep water berth at the vacant site immediately north of Berth No. 5 is being investigated and £10,000 is to be spent on a detailed examination of the project, which preliminary site investigations have shown to be justified.

In addition to the deep water berthing facilities, the lighterage of cargo to and from vessels plays an important part in the clearance of import and export commodities. The lighterage fleet was increased to 47 in 1955 as a measure to counteract to some extent the adverse effect of the berth disaster, and three new 100 ton lighter slipways were recently completed. The construction of a 600 ton slipway is also in hand.

In order to expedite rail clearance from the port, a causeway, 900-ft. long, which will carry both road and rail traffic and link the existing port area with Kipevu and Changamwe on the main Mombasa/Nairobi railway line, is in course of construction and the number of locomotives and freight wagons has been substantially increased.

To increase storage facilities a transit shed was brought into

A new conveyor spanning the railway tracks for delivery of soda from port warehouses to the new No. 8 berth, Mombasa.

East African Harbours—continued

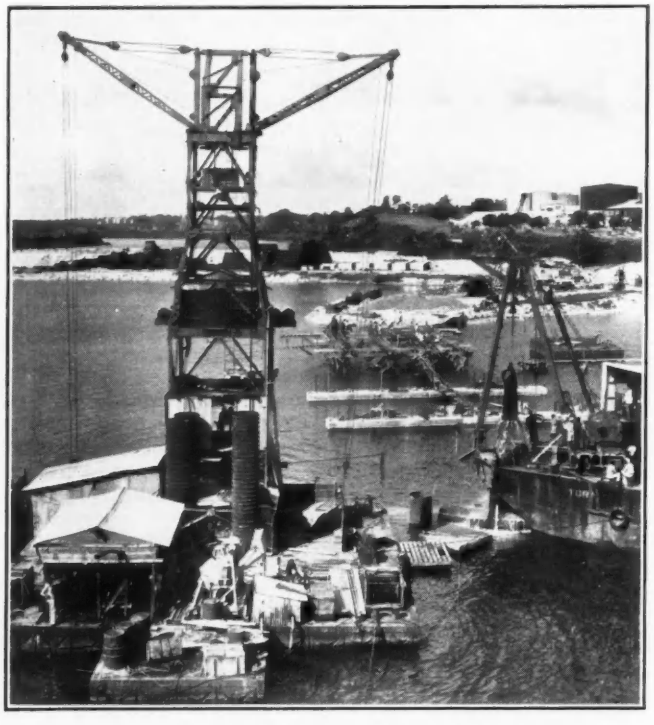
use at the new lighterage wharf towards the end of 1955 and two back-of-port sheds erected, although the lack of electrical equipment severely limited their use. Serving these sheds is a new main port road 1,100 yards long and 30-ft. wide.

All the deepwater berths have been fitted with new cranes and the old cranes have been transferred to the lighterage wharves and to Mbaraki.

Altogether improvements to port facilities at Mombasa will entail the expenditure of some £10,000,000 over a five year period and the ultimate aim is to increase handling facilities by 50 per cent. for despite the improvement shown in 1955, the flow of cargo remains unsatisfactory. As well as actual construction work, investigations are being carried out to determine whether improvements in documentary procedure or cargo handling techniques would speed up the movement of cargo.

Dar es Salaam.

At the lighterage port of Dar es Salaam a total of 828,000 tons of general cargo were handled (excluding bulk oil and coal) which was an increase of 27 per cent. over the total for 1954. These



Pile driving and dredging on the site of the new Kipevu causeway.

increases were brought about despite the fact that no new major improvements in capacity have yet become effective and the new deepwater berths have not yet been brought into use.

All work on the quay walls was completed by December, 1955, and other work such as the building of transit sheds, track laying, etc., will shortly be finished. Site investigations for new oil and dhow jetties have been made and detailed drawings are now being prepared. The expenditure of £165,000 on the construction of a bulk oil jetty for discharge of ocean going tankers at a site away from present and future port developments has been recommended. Lighter turn-round is, in the main, satisfactory, although in 1955 a preponderance of heavy steel work retarded speedy movements owing to the limited space available for sorting.

Tanga.

At Tanga, exports, at 183,000 tons, were 14,000 tons greater than in 1954. The growth of import traffic at this port was almost phenomenal. The year's total of 162,000 tons was 75,000 tons, or 85 per cent. greater than the previous year, mainly due to cargo destined for Kenya and Uganda. The new transit shed became very congested at the end of September because the clearance of goods from the port was slower than the rate of reception from ships. Exceptional facilities, including delivery of cargo outside normal working hours, was introduced, but without much effect and at the end of the year the position remained difficult. In addition, a fire, which occurred in the export shed seriously affected port working for the month of July.

Four of the six five-ton electric cranes ordered for the new lighterage wharf were brought into use in July and August and the remaining two in September. Other than this, no major new facilities became effective, but work was started on rehabilitating the old lighterage wharf and the steel work for a further storage shed was ordered.

Southern Province.

Operating at Mtwara and Lindi was satisfactory throughout 1955. Mtwara tonnages increased from 38,000 in 1954 to 78,000 tons. It is difficult to get a clear picture of regular traffic trends at this port because, during the first half of the year, large tonnages of scrapped tractors and other disposal equipment from the Groundnuts Scheme were shipped from Mtwara and railway materials were regularly imported throughout the year.

Imports into Lindi were about equal to 1954 but there was a drop of 11,000 tons in exports. Owing to the declining traffic at this port a meeting of all interested parties was held in September to discuss its future. It was agreed that the East African Railways and Harbours Administration should retain the lighterage fleet at its present strength until the middle of 1957, or until alternative arrangements could be made for dealing with existing traffic, after which the port would be reduced to the status of a coaster port.

Dock Labour.

The question of dock labour in East African ports became a major problem during 1955. Labour relations at Mombasa, where the port labour organisation and negotiating machinery had for some time been considered inadequate, received a serious blow in the form of a six-day unofficial strike in March, 1955, involving some 10,000 workers including all the port casual labour force and many monthly labourers. It was caused by dissatisfaction over pay, aggravated by an award to Tanga dock workers in July, 1954, and by increases already given to Government and Administration employees under the Lidbury award. The strike ended with the payment of increased rates on an interim basis pending submission of the men's case to an arbitrator. An award, made by Mr. Justice Windham as arbitrator on 28th March, involved increases of about 30 per cent. for all shift workers, with a higher minimum wage, improved leave conditions for regular employees and payment of " dirty money " for some cargo.

Warehousing.

In East Africa, where imports and exports have to travel long distances to and from the places of consumption and production, and where the cropping of some of the major export commodities is seasonal, adequate warehousing accommodation at the sea ports is of vital importance. For many years past there have been divergencies of opinion on whether such warehouse facilities should be provided by the East African Railways and Harbours Administration or by private enterprise. With the growth of traffic and major developments at the ports, this question again came under active survey during 1955 and in an attempt to determine future policy, a conference was held of all interested parties early in December. At this conference it was agreed that the responsibility for long-term warehousing of export cargo should rest with private enterprise and that the Railways and Harbours Administration should provide only transit facilities. It was also agreed, however, that for an interim period from 1st January, 1956, to 30th June, 1957, during which it appeared there might be a shortage of private warehousing facilities, export cargo would be received into the port area at Mombasa for warehousing on terms comparable with those applied by efficient warehousemen. No similar policy has yet been decided for the Tanganyika ports, but it is hoped to have consultations on this question during 1956.

The Port Industry and Mechanical Handling

The Implications of Unit Load Traffic

By M. E. LEIGH-HULME.

NO-ONE with knowledge of the port industry in this country will dispute that the problem of mechanising the handling of cargo through our docks and harbours is a complex and difficult one. It is, however, a fascinating one and although it has been tackled enthusiastically for many years, only part and tentative solutions have so far been found.

Problem of Mechanising Dock Work.

Port operating officials can, of course, get much assistance from machine manufacturers—but they must first make clear their requirements. New machines will only earn consideration if they appear to make for quicker turn-round of ships, speedier handling of goods on quay, in transit shed or in warehouse, saving of shed or warehouse space, of money or of labour, or a reduction of damage risk. Port officials wish to avoid the trap—a much less obvious trap than might be supposed—of mechanising for the sake of mechanising.

Before thinking in terms of machines, therefore, it is necessary to examine what primary handling operations the above-mentioned requirements imply. To turn ships round quickly, speedy quay cranes and ships' purchases are essential; so also are free outlets for imports and quick movement from shed to ship of exports. It follows that for discharging and loading alike, there must be good co-ordination, in both speed and method, of ship and quay work and there must also be ample transit shed space. The availability of such space often depends upon the full and proper use of the shed. At a busy berth essential requirements are high piling and the quickest possible clearance of goods from the shed. Transit sheds are not warehouses.

The enterprising port operating official is always looking for means of doing any or all of this work more efficiently and more expeditiously. He is not looking for a reason to employ such-and-such a machine; he is looking for a machine to eliminate a job bottleneck, to mechanise a single operation or to revolutionise a whole working system. Even if the method already employed is speedy and efficient, it is always possible there may be a better one.

Thus, even though, when inspecting new goods handling machines, he may be specifically looking for a fork-lift truck with a smaller turning circle or a mobile crane with a bigger outreach, he is at the same time a seeker after the truth; for, however keen about the present he may be, he is always considering the question of how mechanisation should or could develop in his industry. This indecision is not due only to the attitude of labour. In port work there is such a large number of different operations on such a huge variety of commodities and packs, in such a wide range of handling circumstances, that it would seem that when all jobs are mechanised, an alarming number of types and kinds of machines and equipment will be required.

Although, had labour been more amenable, the mechanisation of port work would have been far more advanced than it is, progress in this sphere is controlled by other factors besides labour's attitude. These include relative working costs, the need to adapt premises, the availability of machines, maintenance and repair arrangements, battery charging facilities, the requirements of tallying and checking and documentary procedure. To mechanise factory work and dock work are two completely different propositions—and the dock operating official appreciates this when he discusses his difficulties in materials handling circles. In fact, he soon finds that his problem is unique. Such questions as to whether automation is a philosophy or a handling or processing method and whether there will be a reduced need for mechanical handling experts when automatic handling is more common, are to him academic. Whatever may be the answers, they will not apply in the foreseeable future to port operating work. As a fact, it is very difficult to see what will happen in this sphere in the foreseeable future but there are logical reasons for stating that, in the major ports of the world, developments in mechanisation may well occur in two distinct stages.

Mechanisation so far Achieved.

The first stage has begun. Machines have been introduced in a number of ways and for a number of reasons. As already stated, a major controlling factor has been the unco-operative attitude of labour and the mechanisation so far achieved (a pertinent verb!) can be divided into three sections—(1) where it has been accompanied by proper manning scales; (2) where there has been a compromise upon manning; and (3) where the machine has been added to the resources of a manual gang without any adjustment of manning. Progress in section (1) has been most difficult to make; that in section (2) very little easier; and that in section (3) is obviously based on a very dangerous principle and, where it has occurred, has not given port operators much satisfaction.

Since the whole question of manning has ostensibly been properly taken care of in the National Agreement between employers and workpeople) of the National Joint Council of the Port Transport Industry, it is surprising to many people outside the industry that the attitude of the workpeople is so unco-operative. This agreement lays on the employer the responsibility of explaining to the workpeople how the new mechanical appliances it is intended to introduce will be used; and rules that the method of operation, the number of men to be employed and the rates to be paid shall be negotiated by the parties, with the right to appeal to the National Joint Council in the event of disagreement. Disputes and deadlocks on questions of manning are occurring almost daily. Employers of labour know only too well that unless they can carry the workpeople with them, at least a little way, there can be no satisfactory solution of such problems. So often, however, has deadlock occurred because of a blank refusal to negotiate. Reference was made several times recently in the national newspapers of this country to the case where a £200,000 grain elevator with a handling capacity of 200 tons per hour and which was introduced in the port of Hull because manual methods were slow and arduous, was standing by idle for over three months because agreement upon manning could not be reached. The workpeople maintained that a twelve-men gang was needed; the employers, eight—stating that eight is the number found satisfactory at other ports for similar work with similar machines.

Even "settled terms" do not always bring peace; and other industries and other countries have not been so unfortunate as to find so many agreements, negotiated in good faith between representatives of employers and trade unions, almost nullified by the attitude of the rank and file of the workpeople.

Recapitulating, therefore, it is true to say that in most cases where post-war machines have been introduced into port work in this country, the manning scale has had to be settled on a compromise basis instead of on the actual requirements of the job. Despite these frustrating circumstances, the amount of progress made in mechanisation in many British ports is remarkable—and this mechanisation is of the kind described above as "stage one."

The method is to mechanise individual manual operations as and when necessary and possible. For example, the operation of receiving heavy reels of paper from ship and rolling them manually to stowage in transit shed might be mechanised by picking them up at the ship's side by fork-life truck, which will convey them to the shed stowage and pile them three or four high. The benefits of mechanising this operation should include speedier working, much better use of shed space and economy of manpower. The most revolutionary changes in goods handling methods which have occurred in port work for many decades, have, in

Port Industry and Mechanical Handling—*continued*

fact, been brought about comparatively recently by the introduction of the fork-lift truck, often with big dock-tool pallets measuring 4-ft. 6-in. x 6-ft. Once palletised on dock premises, goods can be handled as unit loads, weighing up to 3-tons (the average lifting capacity of modern quay cranes) until they are taken off the pallets when they pass out of the dock operator's custody.

As stated, however, in present circumstances and for general work, the dock operator is interested in a whole range of kinds of machines—quay and mobile cranes, fork-lift and pallet trucks, conveyors, powered platform trucks, tractors, lifts and hoists—and, when considering mechanisation, he will have to bear in mind the controlling factors at his wharf. These will include the type of ship, the commodities handled, the "geography" of the premises, the operations to be performed and (sometimes) the quality of labour available; which in turn will force him to take into account machine lifting capacity, manœuvrability, motive power, type of tyres, stability, outreach (of cranes), lift-height (of fork trucks), operating speeds (hoisting, luffing, slewing, lifting, conveying, pushing, towing), durability, maintenance, charging facilities and, of course, capital cost and running expenses.

The Throughout Movement Method.

The implication of the phrase "in present circumstances" in the above paragraph, is that the requirements mentioned are thought to be those of stage one, i.e. mechanisation achieved by seizing opportunities as they occur, however unlinked or isolated the operations concerned might be. Stage two is the type of mechanisation which may occur in port work as a direct result of the revolution in goods handling methods which the introduction of the fork-lift truck has undoubtedly brought about in industry generally. This, of course, is the employment of the "throughout movement method" by which goods are made into unit loads (usually on pallets) at producer's or distributors' premises and are conveyed as such right through to destination. This method is becoming common in land transport but has not yet appreciably affected seaborne traffic.

In Great Britain, large industrial organisations are palletising their products for distribution, a development which has brought the need to standardise pallet sizes. This need has been met by the British Standards Institution which in 1955 issued British Standard 2629 "Pallets for materials handling," thus further oiling the wheels for the unit load method to extend.

The six sizes standardised are 32-in. x 40-in.; 36-in. x 40-in.; 40-in. x 40-in.; 32-in. x 48-in.; 40-in. x 48-in.; 40-in. x 60-in. and in certain industries not only are package dimensions being adapted to these sizes but premises are being constructed with floors and sections of dimensions which are multiples of those of standard unit loads. Palletised traffic, which at first was carried only by the cartage sections of firms employing palletisation internally, spread in a short time to outside transport contractors, creating an urgent need for vehicles to be adapted if the best "loadability" was to be obtained. These contractors, now finding that handling goods in unit loads instead of as individual packages was an economic proposition, began offering inducements to attract more of this kind of traffic. British railways, for example, announced that subject to certain weight minima, pallets of the sizes recommended in the British Standard would be carried free on both the full and returned empty journeys. To handle this traffic they now provide special vans with 8-ft. 6-in. doorways at the ends of the sides, strengthened floors, and partitions to prevent the movement of pallet loads in transit. They also have in use special wagons for palletised refractory bricks and are experimenting with a prototype vehicle for the conveyance of pallet loads more than one tier high. The quantity of palletised traffic carried annually by British Railways now approaches 200,000 tons.

British Road Services are also catering for palletised traffic. The raves of their new flat vehicles have been made 1½-in. high so that when British Standard pallets are loaded, there is room for fork truck forks to be inserted between the rave and the underside of the top deck of the pallet. Also, with a 1½-in. rave, pallets with in 48-in. dimension can be loaded in two rows with that dimension across a 7-ft. 6-in wide vehicle, both by fork truck over the sides and by pallet truck from the rear. This provides an inward tilt which is sufficient to increase the stability in transit of the whole load. Certain organisations owning their own transport go further than this by providing runners, rollers or partitions which assist in the positioning and carriage of palletised loads.

Such developments have not, of course, been confined to Great Britain. They are occurring wherever palletised traffic is carried and that is in many countries in the five continents. In Australia, Canada and the United States, industrial organisations have taken the initiative. In several European countries it has been the railway authorities who have taken the most important steps to stimulate the growth of palletisation. The Swedish State Railways, for example, provided their goods sheds with four-way 32-in. x 48-in. pallets which they used not only for handling in the sheds but also for conveying goods between railway stations. Later they worked out a standardisation scheme in co-operation with various commercial organisations, as well as with the railway managements of Denmark, Finland and Norway, and the extension of the throughout movement traffic resulting from this scheme has been encouraged by the granting of tariff concessions to consignees forwarding goods already loaded on standard pallets.

The Dutch Railways, too, took steps to encourage consignors to tender their goods in unit load form but perhaps the most interesting advancement has been made in Switzerland, where the initiative was taken by the Swiss Federal Railways. That organisation adopted standard pallet sizes and as a result of close co-operation with private industry, developed palletisation in l.c.l. (less than car load) traffic. The primary step taken to promote the adoption of pallets was the granting of special despatch facilities, rate reduction and the return free of empty pallets. About 560 Swiss firms have joined this special scheme—which is in effect a pallet pool—and, with the railways, keep about 180,000 pallets in circulation. The 32-in. x 48-in. pallet is used exclusively. It is tested for a load limit of 4 tons but may, however, only be loaded with 1 ton. The consignor of l.c.l. traffic, when tendering his palletised goods to the railway depot, receives the same number of corresponding empty pallets in exchange. A similar procedure obtains at the receiving station. Upon delivery of pallet loads to the consignee, the latter immediately hands over a corresponding number of empty pallets to the railway authorities. For the time being this exchange arrangement only exists in l.c.l. traffic. Provisions have been made, however, for its extension to wagon load traffic during the course of 1956.

Palletised traffic with its many requirements (special package sizes, special vehicle types, specially designed premises) is, as stated, appearing all over the world. Except in certain short-sea and coastwise routes, however—such as between France and North Africa, between various countries in the N.W. of Europe and in the "package freighters" of the Great Lakes of North America—it is mainly a land development. To assist its development internationally, standard pallet-sizes have been determined by the International Organisation for Standardisation. These plan-sizes were also, in the main, controlled by vehicle dimensions but the technical committee concerned did take into account the needs of sea transport and included two sizes intended to give the opportunity to modern quay cranes and ships' purchases to lift economic loads. The five recommended sizes are 32-in. x 40-in.; 32-in. x 48-in.; 40-in. x 48-in.; 48-in. x 64-in.; and 48-in. x 72-in. It will be noticed that the three smaller sizes also appear in the British standard.

It took a long time for road and rail transport agents to appreciate the considerable benefits which could accrue to them by carrying unit load traffic. In sea transport, palletised cargo has only begun to appear in isolated instances. Shipping is a more complex industry than land transport and ships are much more difficult and expensive to adapt than land vehicles. Shipping companies are therefore unlikely to give serious consideration to carrying palletised goods until such are actually tendered to their vessels in appreciable quantities. This, in fact, is what many people expect will ultimately occur. With the continuing expansion of the throughout movement method both nationally and (across land boundaries) internationally, it is felt that sooner or later big consignments in unit load form will be tendered to ships engaged in transocean trading.

Port Industry and Mechanical Handling—continued

Unit Load Traffic on Transocean Routes.

It is interesting to try to assess what benefits will accrue when this happens. To whom and in what proportion will they be distributed? A particular point is how the palletiser will recoup himself for the cost of making his goods into unit loads. The interests involved with a shipment of exports in unit load form include (1) the shipper, who will palletise the consignment and handle it mechanically to (2) the transport contractor, who will convey it to the berth; (3) the port labour employer(s) who will unload the vehicle, pile the goods in transit shed, tender them to the vessel and stow them in the hold; (4) the Customs authorities responsible for their clearance; (5) the cargo superintendents responsible for a correct account of their shipment and (6) the shipping company who will be concerned about the space occupied by the pallets and most certainly interested in the effect of palletisation on speeds of loading and discharging.

In theory, the interests which have to **handle** the goods would usually rather handle them as unit loads than as package by package. It is the palletiser and the shipping company who, for the reasons stated, are unlikely to reap benefits easily. In this connection, it is interesting to note that in recent months trial consignments of bricks in unit load form on expendable pallets have been shipped from this country to India. The benefits reaped include savings of time, labour and money at every handling, both here and abroad, and also the elimination of breakages. It is understood that palletisation and banding costs are being paid by the consignee and if this is so, it is a most interesting point.

In the national sphere, the throughout movement method was not finally acceptable until the benefits derived from it were adequately shared. In broad terms, it did not pay manufacturers or distributors to palletise unless they got some of their money back by reduced handling and transport costs. This principle, it would seem, applies equally in the international sphere. A current imperative need is to turn ships round quickly and the carriage of palletised cargo will not be undertaken readily if or when it conflicts with this need.

Difficulties in handling unit load traffic do not usually arise on the dock quay, where consignments can nearly always be received and stowed in shed more quickly than piece cargo. They begin at the time of stowing in ship. The holds of the conventional deep-sea cargo vessel are not constructed for fork-lift truck work or for high piling of unit loads. There are insufficient decks, too many stanchions and other obstructions—such as hatch coamings—and the ceiling of the hold may not be strong enough to bear the weight of the loaded machine or level enough for satisfactory stacking. Unit loads can be placed very conveniently in the square of the hatch; the problem is to convey them under deck and pile them, also bearing in mind stability. Ships' decks are not wide, open, level floors; ships' holds are not square boxes.

It is easy to understand therefore why ocean shipowners, unlike land transport contractors, have not been seeking palletised cargo. It is obvious, too, that, because of this, an important incentive to the development of the throughout movement method in sea transport is lacking. The question raised so frequently, however, is whether ocean shipowners will sooner or later **have** to accept palletised cargo. If they do, it may be that many existing vessels could not be satisfactorily adapted and that new ships would be required designed to a new pattern. In this connection, side ports are a popular conception. This is one of the main reasons for stating that it is unlikely that shipping companies will consider palletised cargo seriously until it is actually tendered to their vessels in appreciable quantities.

As already stated, the belief is held in many quarters that the throughout movement method cannot continue to expand in industry generally without sooner or later infiltrating into transocean traffic. This seems a logical conclusion to draw from existing trends and if it is a valid one, as time goes on consignments in unit load form will be tendered to export berths in increasing quantities.

The Next Trend in Mechanical Handling?

Thus, another radical change in goods handling methods would be necessary in our docks and harbours. To appreciate the extent of such a change, it is useful to try to follow a hypothetical consignment of palletised exports from lorry to stowage in ship's hold. The parcel might consist of six standard pallet-loads of boxed machine-parts, each load being made up of eight 3-cwt. packages. At the export berth these are unloaded and piled three high in two tiers by fork-lift truck in a matter of minutes. Had they gone to the berth by rail, the unloading of the van would have been done by pallet truck. When required for shipment they are unpiled and conveyed to ship's side, also by fork-lift truck, and here they are lifted into the hold with pallet slings on crane or ship's derrick, being conveyed to under-deck stowage by the fork-lift truck allocated to the hold.

It is obvious that, as unit load traffic grows, the need for the dock-tool pallet (and the handling of goods on to it and off it) will correspondingly decrease and there will be a greater demand for fork-fift and pallet trucks at the expense of mobile cranes, hoists, powered platform trucks, conveyors, piling machines, tractors and trailers and, of course, hand trucks In other words, since there will be a big reduction in the number of types of packages and loads, handling methods will be much simplified and the variety of machines required will be considerably smaller. Any appreciable infiltration of unit load traffic into transocean trading would, therefore, cause port operators to review their handling methods and shipowners to re-examine the suitability of their vessels. The question then arises—would labour be any more co-operative in stage two than it has been in stage one?

As has been stated, it has not been possible to accelerate the modernisation of port handling equipment because no guarantee could be obtained that new machines would be operated—certainly to any material advantage. Emphasis in this sphere has passed from demanding obedience to winning co-operation but so far in post-war years the co-operation of labour has been extremely difficult to gain, particularly on the question of manning. In consequence, in many instances where mechanisation could be introduced to great advantage, manual methods still persist.

When palletised unit loads begin to be tendered, however, there will not, as now, be a choice between mechanical and manual handling. Most of them will **demand** a machine, simply because they cannot be man-handled, and surely even the most reactionary union will not continue to demand a gang of manual-handling size when it is only possible to do the work by machine.

The transporting of goods from manufacturer to receiver abroad has been referred to as a huge conveyor system. At the moment, it is a most complicated kind of conveyor, with some parts working quicker than others, with plenty of bottlenecks where the sections join. The introduction of the throughout movement method would simplify and speed up the whole system—and it is surprising what a big proportion of ships' cargoes can be made satisfactorily into unit loads. The idea that in the future the major part of ships' cargoes may be transported to the docks, shipped, discharged and delivered at destination abroad, remaining throughout in unit load form may seem far-fetched. The potential benefits of the method to every interest which has to handle or transport ships' cargoes are so large, however, that it cannot be dismissed as Utopian. Thus the view is cautiously held that surely, albeit very slowly, port operating work will take a new trend—a trend of simplification.

Mechanical Handling Film.

A film " The Seed is Sown " has been sponsored by the Mechanical Handling Engineers' Association to serve as a supplement to two previous documentary films " Mechanical Handling " and " Conveyors As Your Servants." This new film deals specifically with mechanical handling in the grain industry, and part of it shows the various methods of handling imported grain at the large ports in the United Kingdom, where pneumatic and other handling plants are used for the expeditious reception and distribution of the grain, thus ensuring the quick turn-round of large ocean-going vessels. A floating pneumatic handling plant which can be towed alongside any ship in the dock area is also shown.

The film is produced in 16 mm. colour with a sound commentary and has a running time of approximately 26 minutes. It is available on loan upon application to the " Mechanical Handling Engineers' Association," 94/98, Petty France, London, S.W.1.

Bank Protection for Suez Canal

Combating Erosion by Bituminous Facings *

By PHILIPPE PRIEUR, Engineer to the Suez Canal Co.
and
PHILIPPE GILLET, Engineer to "Soliditit Francais"

Introduction

SOME experimental work with flexible mats was done in the Suez Canal prior to 1953. These were manufactured either on the bank in line with the site to be protected or on a floating platform. They were then lifted into the water by means of a crane, or slid off the platform which was inclined at an angle. These experiments were not successful, however, as whichever method was employed the mats were partly broken or bent by the time they reached the canal bed. The current and eddies then completed their destruction and swept them away piece by piece.

As a result of further experiments, new methods, which are the subject of this article, were tried out in 1953 and 1954, along lines advocated by "Soliditit Francais."

Instead of immersing the mats separately, as had been done previously, the new method consisted of welding the mats together in series, just prior to immersion. The linked mats, when in position, form an uninterrupted band stretching along the stone facing to the banks to as great a distance as may be required; thus a continuous protection running to several kilometres in length can be achieved. Moreover, by manufacturing the mats in a specially equipped plant the greatest care can be brought to their fabrication, and a guaranteed quality can be assured. Transport of the mats from the factory to the site of immersion is effected by barges.

This double method, i.e. prefabrication plus welding, finally brought about the desired results. A great many difficulties had however to be overcome, in view of the fact that the principal operations of this method had never been done previously. The principal problems were the handling of large flexible mats by means of suckers, and immersion of the mats in a continuous ribbon.

Bituminous Mats

The mats used in the Suez Canal have the following specification. They measure 3 m. x 8 m. and consist of a layer of mastic asphalt 6 cm. thick, and reinforced in three different ways. (The specification of the asphalt is described in a previous article which appeared in "Travaux," November 1955.) There is a layer of steel netting embedded half way through the thickness of the mat. This provides enough resistance to traction and flexion once the mat is secured on the bottom. It also prevents any accidental crack in the mat, caused by jerks in the towing for instance, from widening, and helps to preserve a certain amount of cohesion while preventing progressive crumbling. In order to fulfil these requirements the netting has to be firm, flexible, rustless and capable of adhering to the asphalt.

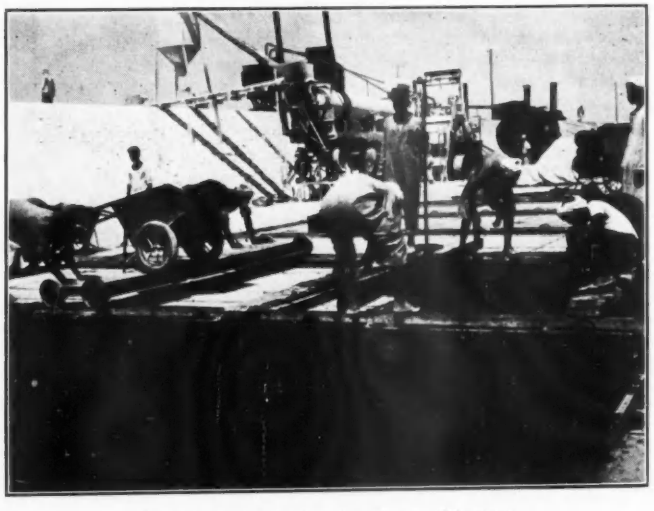
This netting, however, would not in itself be enough to bear the considerable strain imposed on the mats while they are being pulled into position. There are accordingly steel wire cables also fitted, capable of taking the whole load while the netting distributes the strain through the mat. Six of these cables are provided; they are stretched longitudinally along the mat and bound to the netting along their whole length. When the mats are immersed, the cables are linked from one mat to the next with the result that if water eddies, or any other pressure from beneath, tend to raise a mat, it is held down by its neighbours on either side.

The third reinforcement consists of anchoring cables, of which there are two or three per slab. These are set at right angles to the other cables, fastened to the netting and to the cables, and looped where they project from the side of the mat. A metal anchoring stake is driven through the loop once the mats are in place.

*Abridged translation from the December 1955 issue of "Travaux"

Slab Manufacturing Plant

The plant consists of apparatus for preparing mastic asphalt together with beds on which the asphalt is cast to encase the netting. Bitumen is supplied in bulk in lagged tanker lorries from the Suez Refinery. The components of each mix are measured by weight, and the mastic is prepared at about 200 degrees centigrade. There are three casting beds, each of which can accommodate seven mats; thus work can proceed on 21 mats simultaneously in varying stages of completion. The casting of a mat whose area is 24 sq. metres, calls for approximately ten batches of mix of 350 kg. Casting is done at about 180 deg. C. The mats are removed from the moulds on the following day and shifted off the beds the day after.



Pouring the asphalt mats prior to shipment.

Handling the Asphalt Mats

The method used for handling the mats was also one recommended by "Soliditit Francais." It was made necessary by the need to handle these large mats, each weighing 3,600 kg., rapidly with the minimum of hitching and unhitching, and without any risk of deterioration. A method was adopted by which suckers were employed, after the Vacuum Concrete principle of handling. A prototype frame with suckers, called "Octopus," was built in Cairo in 1953 by the African Enterprise and Development Company, holders of the Vacuum Concrete patents for Egypt. This first Octopus was modified at the Canal Company's works in the spring of 1954, and a second one was built on the pattern of these modifications.

These "Octopus" mainly consist of a steel frame supporting forty suckers which are equally distributed over the whole surface. All the cups are linked to a vacuum pump by means of a main pipe, also mounted on the frame. To lift an asphalt mat, all that has to be done is to place an Octopus over it, turn on the vacuum pump and then lift the frame which takes the mat with it, adhering to the cups. Although at the time when these trials were first made in the summer of 1953, this method had often been used for lifting rigid slabs of cement or panes of glass, it had never before apparently been used for flexible or deformable asphalt mats, which were very liable to lose their shape. The application of this method was not brought about without a number of alterations and adjustments. Ultimately, however, the technique of lifting the mats was so improved that a slab could be handled in two minutes.

Bank Protection for Suez Canal—continued

The Octopus method of handling has certain obvious advantages. It places no strain on the wire reinforcement, the slabs are not liable to be broken and all hitching and unhitching is eliminated. Such a simplification saves a great deal of time. The mats are raised by one Octopus from the casting beds and loaded on to lighters. Each lighter takes two stacks of ten mats. A layer of filler is spread between each mat to prevent adhesion in the high prevailing temperature. The lighters are then towed to the site where mat-laying is in progress.

Laying the Mats

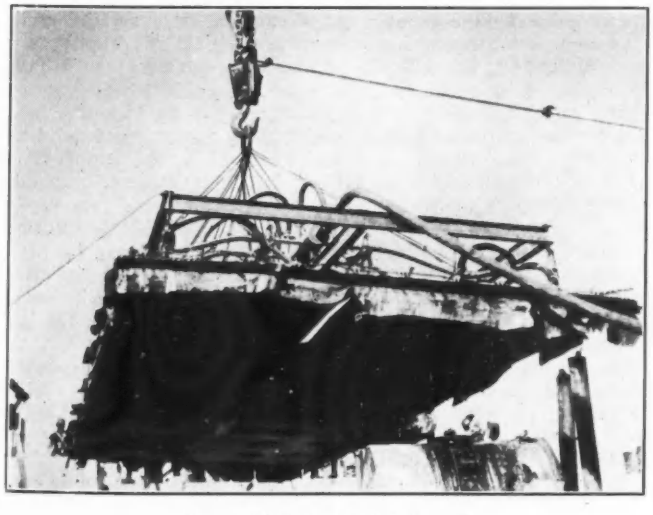
The method of laying the mats has already been briefly referred to. It consists of the following operations:

1. The mats are welded end to end, prior to immersion.
2. The ribbon of mats thus formed is made to slide into the water parallel to the bank.
3. The ribbon is finally anchored to the bottom by means of iron stakes driven under water beneath the embankment wall.

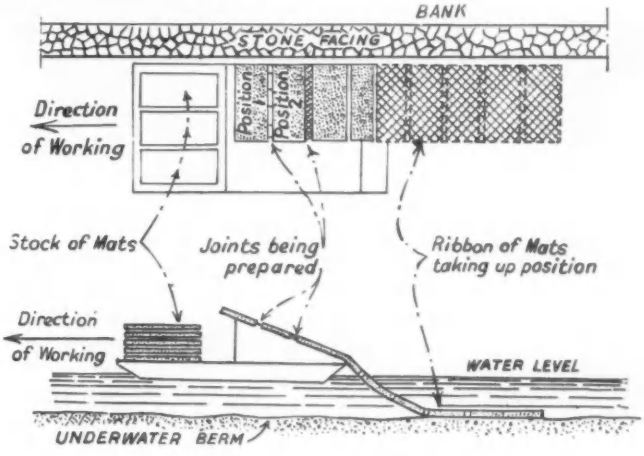
All these operations were carried out by means of a specially devised piece of apparatus called the "mats laying machine." This machine was built out of three 100-ton lighters. It contains an inclined platform, or working platform where the mats are coupled, grouted and made to slide into the water. The angle of the platform is determined by experiment so that the mats slide off fairly easily but without getting out of control. There is also a loose platform, which hangs from the inclined platform on hinges, and serves to guide the slabs in their resting place on the canal bottom. Other equipment on the machine includes a pair of capstans for warping the machine along the bank, and a derrick carrying an Octopus to lift the mats from barges on to the working platform.

Mat-laying: Operational sequence

The Octopus lifts a mat, from the stockpile on the machine, or from an adjacent lighter, and lays it on the upper part of the working platform. (There is room on the platform for more than three slabs at once.) The six reinforcing cables mentioned previously are attached to those of the mat lying further down the platform. As soon as this is done, the whole apparatus is warped along the canal bank a distance equal to the length of a mat. Thus the mat now takes its position further down the slope of the working platform, and can be replaced by a fresh mat at the top of the platform. At this stage the netting reinforcement of the mat is joined to that of the one lower down the slope and hot mastic asphalt is poured into the junction between them. The mastic is of the same composition as that of the mats themselves, and the result is to make an uninterrupted ribbon of reinforced asphalt. While this is being done, a third fresh mat is positioned at the top of the platform by the Octopus and the original mat in this description is ready to take the water, sliding slowly down over the hinged platform until it rests on the bottom.



A mat lifted by the "Octopus."



Schematic representation of the method of mat laying.

When starting a fresh section of mats, the six cables of the first mat are anchored to a barge placed at right angles to them. The force required to get this first mat into the water is considerable, and this starting off manoeuvre is always a delicate one.

The above description is only a rough outline of the operation. In practice, a great number of supplementary manoeuvres were required, whose description would be tedious.

Consideration also had to be given to the hydraulic conditions peculiar to the canal and to the eddies caused by the passing of large ships, the more so since the site of mat laying was usually in waters subject to strong eddies which themselves had caused the erosion which it was aimed to arrest. Also, when convoys passed by, the violent movements of the mat-laying machine would have broken the mats at the join between those under water and those still on the platform, had not a method of anchoring been found which made it possible not to interrupt the work. The convoys had to slow down, however, while passing the machine.

Durability of the Mats

As mentioned above, the mats laid individually in 1951 and 1953 had mostly deteriorated. Some of them are still in position but the majority of them are in fragments inefficiently linked by the remnants of netting and cables. By contrast the mats laid by the method described above during 1953 and 1954 are in good condition today. Not one has been torn away or damaged. Divers go down about every three months to check that they still adhere to the canal bed and show no signs of erosion. Only one gash in a mat has been seen, probably caused by accidental collision with a tug's stern, but this did not widen during ensuing months.

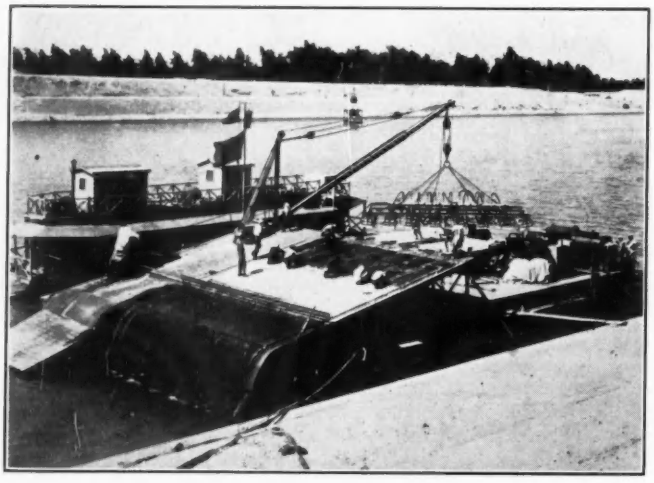
Speed of Working

On account of the restrictions on working time imposed by the passing of ships, it was at first decided not to attempt to lay more than seven mats a day. This corresponds to protecting about 500 metres of bank per month. However, during the trials this rate was greatly exceeded, and it is estimated that the protection of 1 kilometre per month is quite feasible by this method. At this rate, the cost would be less than that of the classical methods of reinforcement of the banks, using abutment blocks and piling.

General Conclusions

In any comparison of the continuous mat method with the use of mass asphalt, the former is definitely superior and is more reliable in results. Indeed the quality of the mat covering, made with the utmost care on land is infinitely better than that of asphalt poured in bulk under water. Moreover the mat covering is reinforced,

Bank Protection for Suez Canal—continued



The mat-laying installation at work.

continuous and every square metre is integral with the whole. Finally its smooth surface facilitates the free flow of waves.

The experiments described above were directed, inter alia, to ascertaining whether the mat system would suit the particular case of the Suez Canal. The trials in 1953 and 1954 give affirmative results. The 1953 trials had shown the technical feasibility of the method, and the usefulness of a mat laying machine. The 1954 trials show that it was possible to industrialise the method to secure a rate of protection of 1 kilometre per month, as a reasonable cost, and that the results were durable and effective. This is not to say that the mass asphalt method is ruled out entirely; it is a method which requires neither large investment nor special equipment. For small local repairs, and the protection of short sections, the method is still of value.

In conclusion, it should be said that the work could not have been brought to such perfection without the extremely close collaboration which existed between the laboratory and the yard, whereby suggestions and comments made on site were used to revise and correct the instructions initially issued from the laboratory. The value of the final results is the consequence of such meticulous co-ordination.

Progress of Eighth Improvement Programme

It has recently been stated that part of the work of deepening the Suez Canal, authorised under the Eighth Programme of Improvements is to be carried out by draglines.

The Eighth Improvement Programme, which was agreed by the Suez Canal Company's Administrative Council in December 1954, and was reported upon in the July 1955 issue of this Journal, originally envisaged that, among other works, the widening and dredging of the section of the Canal between Kms. 134 and 157 should be carried out by means of bucket dredgers Because of passing convoys however, the adoption of this method would have meant that the dredgers could only operate twelve hours in twenty-four. A counter proposal was therefore advanced, to use mammoth dragline dredgers, and this proposal, submitted by Messrs. Ackermans and Van Haaren, a Belgian firm, was accepted by the Company. The draglines will be able to move 250,000 cubic metres per month, working twenty-four hours a day and this will enable the work in the section concerned to be completed in twenty-one months.

The machines, which Messrs. Ackermans and Van Haaren intend using, are sometimes referred to as "walking draglines" as they lift and move themselves along a special roadway at the rate of approximately one kilometre every twenty-four hours. The company have purchased in the United States two large Marion diesel-electric draglines and one Bucyrus dragline, one of which has already arrived in Egypt and is being assembled. The super Marion dragline has a span of 70 metres (about 235-ft.) and the Bucyrus a span of 125 metres (80-ft.), with an approximate capacity for both of five to nine cubic metres, according to the span. It is estimated that the draglines, working from an embankment which is being constructed on the eastern bank of the Canal, and operating between the moving ships will complete the work early in 1958.

The widening of the Canal by 20 metres (65-ft.) to a depth of 13.50 metres (44-ft.) between Kms. 146 and 155.220, will involve the removal of between 1,000,000 and 1,500,000 cubic metres of earth. Four 191 h.p. caterpillar D-8 tractor bulldozers and three No. 80 Birtley 23 cubic yard scrapers have since October last, been in full operation working 10 hours daily, and up to the beginning of this year had moved approximately 350,000 cu. metres of earth.

Port Said By-Pass

Work is now being carried out on the cutting of a new channel from the Petroleum Basin at the south of Port Said harbour to a point 7.6 kilometres up the Canal from Port Said. This cutting will run parallel to the existing Canal and will be divided from it by islands. Considerable progress has already been made and it is anticipated that the work will be completed by the end of 1956. Two dredgers are removing some 350,000 cubic metres of soil per month and it is estimated that approximately 7,000,000 cubic metres of spoil will have to be excavated. Southbound ballast tankers and other vessels having no operations to carry out in Port Said will be moored in this cutting, from where they will be able to proceed into the Canal immediately the last northbound ship has passed the junction with the main Canal at Km. 7.6, thus saving approximately one hour.

Dredging is also proceeding on the Kabret By-Pass, which is to be a 3.7 km. long channel excavated in the southern part of the Great Bitter Lake parallel to the Maritime Canal. When completed, this channel will allow south- and northbound ships to pass one another. It is hoped that this work will also be completed by the end of 1956. The contractors are using three bucket dredgers capable of removing 500,000 to 600,000 cubic metres of spoil per month. The channel will have a guaranteed depth of 12 metres, dredging being carried down to 13.5 metres.

Other work to be undertaken in 1957 includes the widening by 10 metres of the by-pass known as the East Branch (ex Farouk) between Km. 50 and Km. 62. This channel was only opened to shipping on July 3, 1951.

The Professional Engineers' Appointments Bureau.

The Report for 1955 of the Professional Engineers Appointments Bureau, 9, Victoria Street, London, emphasises the continued shortage of civil, mechanical and electrical engineers. There is no indication that the number of engineers seeking appointments, either at home or overseas, is adequate in any field to fill current vacancies. There are a number of changes by engineers from one appointment to another, either for personal reasons or to gain wider experience, and these changes are of value to employers generally if the engineers concerned are progressively able to accept greater responsibility, but the difficulty of finding an engineer who is fully experienced in a particular field is not lessened. Firms who are rapidly expanding are having great difficulty in securing staff who have the specialised experience which their vacant posts require.

In 1955, there was no significant change in the numbers of engineers registering with the Bureau, but the number of vacancies notified increased by 20 per cent. The total placings rose by 15 per cent. above last year's figure but the more rigid specification of requirements laid down both by those registered and by prospective employers, tended to reduce the field of selection. A larger proportion of placings was for senior appointments but with fewer men available for junior posts, the number of placings in the low salary ranges was reduced.

The Registrar reports that many more employers and engineers approached the Bureau to discuss their problems, and to review the general employment market. Such contacts are of real value and the Registrar is always glad to offer the facilities of the Bureau to any Corporate Member, Graduate or Student of the Institutions of Civil, of Mechanical and of Electrical Engineers who is contemplating a change of post, and to any employer who wishes to fill a vacancy.

The Great Ouse Flood Protection Scheme

Drainage and Engineering Works in the Fens

By W. E. DORAN, O.B.E., B.A.I., M.I.C.E.

(Continued from page 374)

The Tail Sluice

It had been intended originally to use normal reinforced concrete for the construction of the Tail Sluice. This proved impracticable because the buttery clay would not stand at a slope steeper than 4 : 1 and the sides of the excavation could not be held with piling.

It was therefore decided to use concrete caissons for the abutments of the sluices. This would enable the excavation to be done for the floor of the sluices and the piers could then be built in the normal way.

The completed structure will consist of seven openings 30-ft. wide, with piers 8-ft. 6-in. wide and 103-ft. 6-in. long. Each opening will have a steel lift gate 30-ft. span by 22-ft. high. Behind the lift gates will be automatic tidal flap gates. When in operation the steel lift gates will be raised and the flap gates will allow the water to discharge into the Tidal River until the rising tide causes them to close. A 12-ft. wide roadway is provided across the sluice. The arrangement is shown in section in Fig. 5.

The sinking of the caissons for the abutments is now completed. Each abutment is made up of five caissons 18-ft. 6-in. wide by 36-ft. 8-in. long, divided into three compartments by 3-ft. thick walls. The caissons are made of mass concrete and were constructed in seven lifts, each of 6-ft. Sinking was effected by grabbing out the clay from the interior and loading the caisson with kentledge. Up to 128 tons of kentledge was needed as the depth increased. On reaching the hard clay, excavation by hand labour, with compressed air spades, was resorted to. By careful adjustment of the kentledge, sinking was satisfactorily accomplished, the maximum deviation from the vertical being about 6-in. A space of 3-ft. was left between each caisson to allow for deviation in sinking and these gaps will be closed by steel box piles.

The abutment wing walls have been constructed in the same manner.

The " seen face " of the caissons will be covered by a concrete facing 3-ft. thick, so that any deviation from line or verticality can be accommodated.

Head Sluice

The Head Sluice, which will admit water from the Ely branch of the Ouse, known in this reach as the Ten Mile River, is of similar design but with three openings of 30-ft. and, of course, without the tidal flap gates. There is a bridge providing an 18-ft. roadway and a footwalk 5-ft. 8-in. wide. It is not anticipated that the caisson method of construction will be required at this site.

Road Bridges

The road bridges are similar in general design. At Saddlebow, Wiggenhall and Magdalen there are three openings of 56-ft. span between bridge piers and two openings of 46-ft. between each abutment and the next pier. The piers are 4-ft. thick.

The abutments are of reinforced concrete resting directly on the Kimmeridge clay in the case of Saddlebow and supported on bearing piles in the two others.

The piers are of mass concrete.

A 20-ft. wide roadway and two 5-ft. footways are provided.

The three reinforced concrete beams under the roadway are 18-in. wide and 5-ft. deep. The outside beams under the footways are 18-in. wide and 3-ft. 10-in. deep.

In accordance with the recommendations of the Fine Arts Commission, the exterior surface of the parapet walls is of Portland stone concrete. To relieve the plain surfaces of the piers and abutments, a set back of ½ depth is made at 3-ft. vertical intervals, similar treatment being employed for the sluices.

The bridges at Stow and Downham are similar in general design, except that the bed width of the channel at these sites is 175-ft. and the bridges cross it on the skew.

Flood Protection Scheme — Part II

The work on the Relief Channel described above is due for completion in July, 1959. Although it would, by itself, reduce high flood levels in the South Level, no considerable reduction would occur, especially in the Southern part of the river system, until the existing Ten Mile and Ely Ouse river has been improved. This is

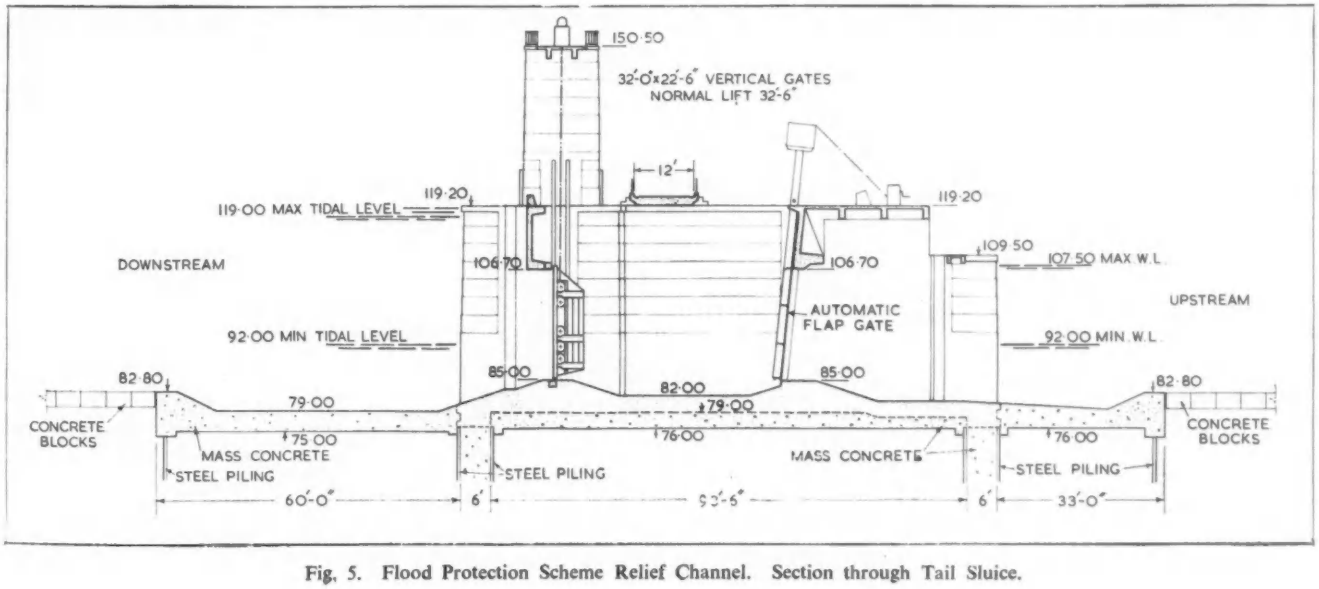


Fig. 5. Flood Protection Scheme Relief Channel. Section through Tail Sluice.

The Great Ouse Flood Protection Scheme—continued

Saddlebow Bridge—Deck concreting in progress.

the work included in the second part of the Scheme, the contract for which will be let next year, so that this work may be completed by the time that the Relief Channel is ready for use.

It will be remembered that when the Cut-Off Channel has been made, it will intercept 40 per cent. of the flood discharge flowing into the South Level system. The remaining 60 per cent. is accounted for mainly by the flood discharge of the river Cam, which is estimated at 2,500 cusecs and enters at the most Southerly part of the system, and by the discharge from the various pumping stations of the Internal Drainage Districts, which between them amount to 2,400 cusecs. In addition, there are, of course, various high-level drains or " lodes " and small catchwater drains. The total discharge from all these various sources is estimated at 6,100 cusecs.

It has been decided that under criterion flood conditions the water level at Ely should not be allowed to rise above 9.5 above O.D. (Newlyn). To achieve this it will be necessary to increase the channel section considerably.

The scheme provides for the deepening and widening of the river, and the setting back of the flood banks where required from Denver Sluice to the mouth of the Cam, a distance of 18¾ miles.

For the first five miles above Denver Sluice the river was widened and deepened in 1938 by the Ouse Catchment Board, and along this length deepening only will be needed, amounting to a further 2-ft. 6-in. to 3-ft. over a bed width of 60-ft. Beyond this point more extensive work is required.

A typical section is shown in Fig. 6. It will be seen that along this particular length a public road, which at present runs along the berm at the back of the flood bank, has to be diverted to a new alignment, a new flood bank has to be made behind the existing one and finally the existing bank has to be removed and the channel widened. The main work is confined to one bank, in some places the left bank and in others the right bank. The alignment chosen takes into account local circumstances, such as the existence of a road, the presence of a bend in the river, etc.

The work has had to be planned so that no flood bank is cut down during the period from the end of September to the end of March. Partly on this account the duration of the contract has been fixed at four years.

Unlike the Relief Channel, which, so far, has been excavated in the dry, we are confronted here with a river up to 18-ft. deep flowing several feet above the level of the land behind the flood banks. No liberties may be taken with it.

The flood banks had their beginnings some three hundred years ago with the peat banks thrown up by the Adventurers. Along the Ten Mile, some of the bank material is tidal silt dating from pre-drainage days when the river was the tidal Ouse. For good measure let us add the buttery clay, whilst above all this is the Kimmeridge clay added over the years in successive bank heightenings as the banks subsided.

Although the buttery clay South of Denver is only a few feet thick and is of a somewhat stiffer consistency than that encountered near King's Lynn, the nature of the subsoil does impose a limit to the weight which may be placed with safety near the river channel. The small top width of the flood banks is another limiting factor in the use of large machines. This suggests that floating plant may prove necessary for dredging the channel beyond the reach of land based excavators.

In this respect the River Board, which maintains a fleet of barges and tugs, may be able to assist.

Where new flood banks are made it is necessary to prevent seepage through the peat or other pervious soil. This is done by means of a cut-off trench 10-ft. deep or so filled with clay.

The diversity of soils in which the excavation is to be made will have its effect upon the planning of the operation. Good clay must be used up to a certain height on the front of the flood banks; unsuitable spoil which may be met before the clay is reached must be put aside and so on.

On balance, there is a surplus of excavation which must be transported to places reserved for spoil dumping.

The total quantity of excavation amounts to about 2 million cubic yards.

Structural Works

The structural works in Part II are confined to two new bridges, a bridge at Denver over the line of the future Cut-Off Channel, which, for convenience, is included in the contract for Part II, and a new bridge at Littleport to replace the old steel bridge owned by the River Board which cannot be adapted to the widened channel.

Altogether nine bridges are affected by the widening, but by the use of steel sheet piling and, in some cases, by mattress protection work, it has been possible to get the required channel section without detriment to the structures.

Cut-Off Channel — Part III

The third part of the Scheme is the making of the Cut-Off Channel from Denver Sluice round the margin of the fens to Barton Mills in Suffolk. This channel will be 29¼ miles in length. Until it has been completed, the Scheme cannot be fully effective.

As may be imagined, the line of the channel cuts across a great many roads and rights of way. It will be necessary to build 26 road bridges and 3 railway bridges. A certain amount of new road work is also needed.

The excavation of the channel itself does not present any particular difficulty. The bed width varies from 70-ft. at Denver to 14-ft. at the take off from the Lark. The work is not entirely without its soil problems, but at least two of these are of an entirely different nature from those previously mentioned.

The channel runs for most of its length through the sandy soils characteristic of the " Breckland " and at its Southern end it will be mainly in chalk.

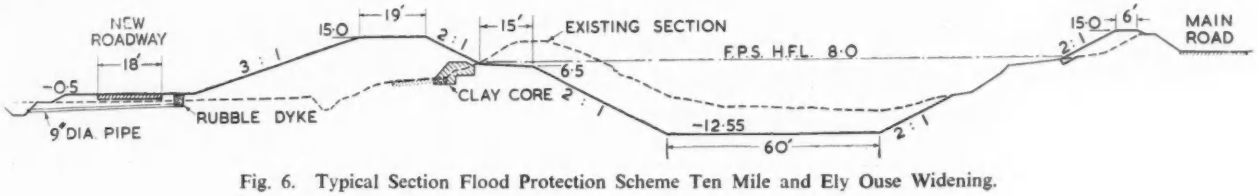


Fig. 6. Typical Section Flood Protection Scheme Ten Mile and Ely Ouse Widening.

The Great Ouse Flood Protection Scheme—continued

The approximate mileage in the various types of soils is 16½ miles in sandy fen alluvium, 6½ miles in chalk, 5 miles in sand and gravel, and 1¼ miles in stiff clay.

So far as the sandy soils are concerned, the problem is the behaviour of the side slopes of the channel and their protection from erosion.

Some years ago the River Board undertook to excavate a new diversion channel in the area referred to in connection with an aerodrome extension. The foreman in charge of the work was noted for his high standard of workmanship, indeed his drain batters and banks when working in his normal environment of clay looked as if they had been cut out of processed cheese. Imagine his extreme frustration and mental disturbance when he arrived one windy morning to see most of his neatly formed spoil bank literally "gone with the wind"!

The chalk and the permeable sands and gravels raise a different kind of problem—seepage. At normal retention levels the question is not serious, but at flood levels the head of water on the fissured chalk may increase the flow in the chalk springs which come up in the fens to the West of the channel. This would be objectionable because the springs are in an area which is drained by pumping.

Sluices and Syphons

Where the line of the Cut-Off Channel intersects the rivers Wissey and Little Ouse, the rivers are carried over the Cut-Off in a concrete channel of approximately semi-elliptic section, the Cut-Off itself being taken underneath in an inverted syphon (Fig. 7). At the Wissey intersection, the syphon consists of five openings, 10-ft. square, separated by 18-in. walls. Each opening is provided with a steel sluice gate on the upstream end for regulating purposes. Damboard grooves are provided at the downstream end to facilitate de-watering for inspection.

Above the syphon crossing are two 25-ft. span sluices, one across the main river and the other on a branch channel connecting with the Cut-Off, by means of which the full flow, or any desired proportion thereof, can be diverted into the Cut-Off.

The Little Ouse crossing is a similar arrangement, the syphon having three 10-ft. square openings and the main control sluices having two openings of 20-ft. span each.

By choosing sites where there is a bend in the river, it is possible to construct these works "in the dry" and divert the river through them on completion.

The Head Sluice, which will control the admission of water from the River Lark, near Barton Mills, into the Cut-Off, is of concrete construction, with a steel lift gate 20-ft. span and 12-ft. 6-in. high. The overhead gantry for the gate operating gear is of reinforced concrete, as it is also on the other sluices. Steel cut-off piles are used under these different structures to prevent under-seepage.

As there is a considerable fall from the Lark to the Little Ouse crossing, three weirs are required to control the water levels, two of them being incorporated with road bridges.

Road Bridges

The considerable number of road bridges required over the Cut-Off Channel provides a suitable application for pre-stressed concrete using standardized units post-tensioned on the Freyssinet system.

On the reach between the Wissey crossing and Denver, where the channel is widest, three span bridges are to be used. There will be four having a centre span of 50-ft. and two side spans of 40-ft., and one with a centre span of 42-ft. and two side spans of 34-ft.

For the remainder of the channel 22 single span bridges of from 57-ft. to 70-ft. span are required.

The designs for the reinforced concrete work for the bridges and sluices for the whole of the Flood Protection Scheme have been prepared for Sir Murdoch MacDonald and Partners by Messrs. Considere Constructions Ltd.

The Wash Protective Works

Although several problems arising out of the construction of the Scheme have been referred to, the most difficult of all has been reserved for mention at the end. This is the problem of protective works in the Wash.

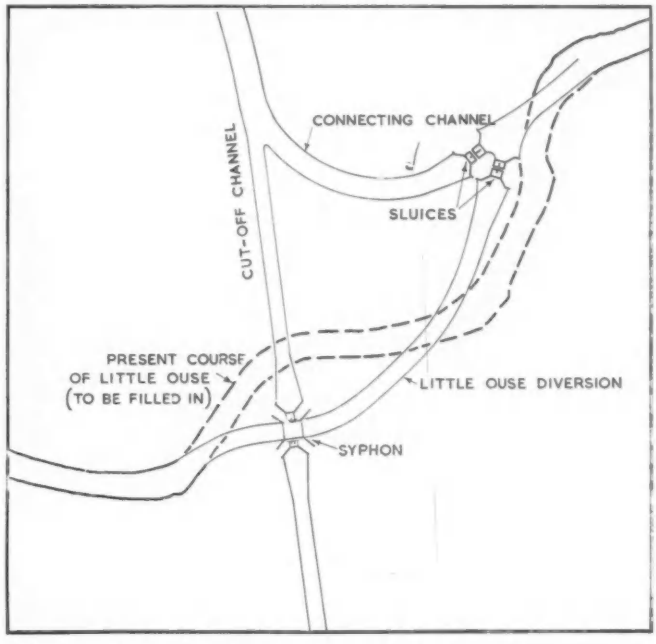


Fig. 7. Flood Protection Scheme Cut-off Channel. Arrangement of Sluices and Syphon at Little Ouse Crossing.

The river Ouse finds its way to the open sea through the silt banks of the Wash and, as is well known, the course of its channel is much subject to change.

In 1775 the shipping channel to King's Lynn was in an Easterly direction via Cork Hole; in 1811 it had deserted the East and returned to its former exit via the Lynn Channel in the West. It remained in the West until 1940, when it switched again to the East.

The Admiralty Chart of 1943 shows a reasonably direct channel from the training walls at the mouth of the river to Cork Hole.

It will be remembered that the King's Lynn Conservancy Board are concerned about the possible effects of a high flood discharge upon the shipping channel in the Wash and that under the Great Ouse Flood Protection Act the River Board may not make use of their new works until agreed protective works have been done.

When agreement was reached in 1953 on the subject of the works to be done to satisfy the requirements of the Conservancy Board, Messrs. Kelvin and Hughes were requested to carry out a survey for the purpose of designing the works.

The survey became available in September, 1953, and it was noted that the position of the shipping channel had altered considerably since the previous survey in 1949.

It was decided to repeat the survey in 1954. This showed still further movement; the Northern bend of the channel was moving towards the East, whilst the Southern part was moving Westwards, resulting in an S-shaped channel. The maximum movements were approximately 500 to 600-ft.

A further survey completed in September, 1955, shows a still greater movement in the same sense and the bends are now more pronounced than they were previously.

The variation in the channels at Chart datum are shown on the diagram Fig. 8.

The protective work agreed upon was the revetment of the West bank of the shipping channel from the training walls to a point round the first bend.

The channel has now reached a stage where the possibility of a switch back to the West cannot be ruled out. Experiments carried out on the River Board's Tidal Model of the Wash at Cambridge suggests that this is what will happen. If this occurs, the revet-

The Great Ouse Flood Protection Scheme—continued

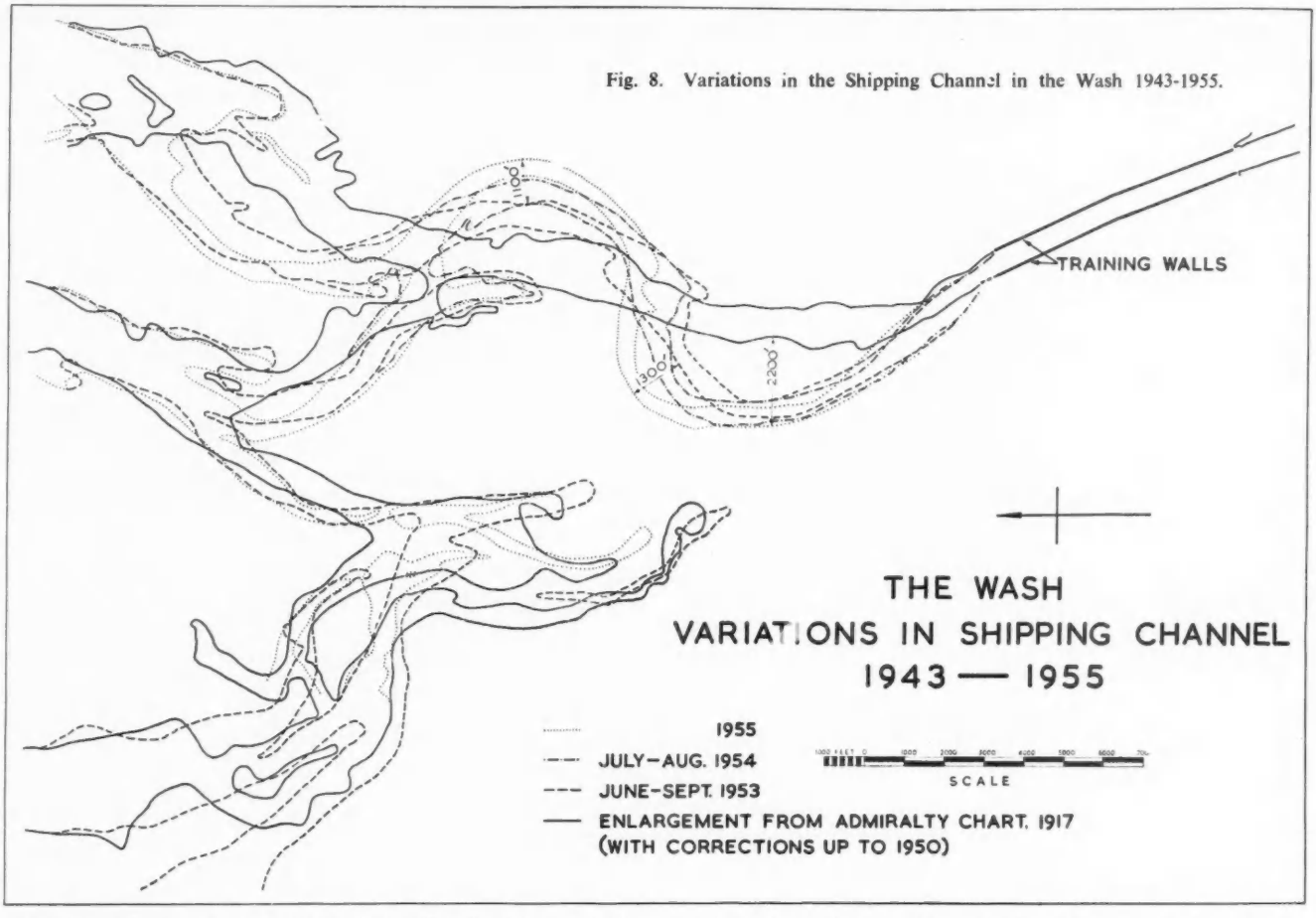


Fig. 8. Variations in the Shipping Channel in the Wash 1943-1955.

ment will have to be on the East side instead of the West, and the alignment will be different.

Can the channel be prevented from switching to the West?

If so, would it be desirable to prevent the switch?

Will the Westerly channel have opened up markedly by the Spring, when work in the Wash becomes possible?

These and other questions are being studied by the advisers of the River Board and the King's Lynn Conservancy Board.

It is at least clear that the shipping channel has been changing its position very much more rapidly than the rate at which protective work could be carried out, more rapidly, in fact, than the most efficient survey team can survey it, hence it is impossible to determine in advance the line which the work would follow.

One must conclude that the training of the shipping channel in the Wash is a hazardous and costly undertaking and that the result is uncertain.

New Facility at Port of Melbourne

Modern Steel Handling Berth

What is claimed to be the most modern building in any Australian port is to be erected at No. 21 South Wharf for the Melbourne Harbour Trust Commissioners on whose behalf tenders were recently called by A. C. Leith and Bartlett, Architects and Engineers.

Of contemporary design, the building assists in solving the problem of space limitation along South Wharf by elevating the main structure on columns, with a vehicle parking area underneath. Office accommodation is provided for activities at the berth which will be devoted to mechanised steel handling, and ample provision has been made for dining rooms, ablution blocks fitted with hot and cold showers and other amenities. The port workers' dining room will provide seating for 142 men simultaneously, and provision has been made for the later installation of a cafeteria.

The new building will be of rigid steel frame construction, with steel roof purlins covered with interlocking steel roof decking. The sides of the structure are to be of aluminium curtain wall construction with porcelain enamel spandrels. The ends of the building will be of pre-cast concrete slabs with exposed aggregate treatment. Special heat diffusing "Thermosel" glass will be fitted, reducing ultra violet rays, temperature and glare and helping to ensure that working conditions will be comfortable at all periods of the year. Fluorescent lighting is to be provided in shed and on wharf.

The office accommodation provided caters for the needs of the Trust, shipping company, steel importing company and police. A garage for mobile cargo handling equipment and a workshop are also included in the design, as well as ample parking space for cars.

This new building will serve a mechanised steel handling berth now rapidly taking shape and at which the steel framework of a shed 420-ft. long and 150-ft. wide is being erected. The shed comprises seven 60-ft. bays, served by overhead shed cranes working to the wharf apron where 6 ton level-luffing cranes will discharge steel cargoes. Between shed and office building area runs a roadway 100-ft. in width which readily permits manoeuvring by large semi-trailer vehicles. The overhead shed cranes travel on tracks which project beyond the shed and enable vehicles backed up to the shed to be loaded direct.

The steel handling berth will permit the rapid turn-round of ships engaged in the steel trade and will free, for other purposes, three berths now employed virtually full-time with this class of cargo.

Ports Efficiency Committee Report

Recommendations for Regulating Flow of Goods

The Third Report of the Ports Efficiency Committee, which was published on the 10th May (H.M. Stationery Office, price 9d.) is confined to the problem of road transport delays within the docks. The Committee was established in March, 1952, to investigate the working of the ports, particularly London and Liverpool, and to secure the co-operation of all interests concerned in ensuring a quicker flow through the ports of inward and outward cargo. The present members are: Sir Ernest Murrant, Sir Leslie Ford, Sir Robert Letch, Sir Eric Millbourn, Mr. M. Arnet Robinson and Mr. Tom Yates.

The report points out that the Committee has kept to road transport within the dock as opposed to road access to the ports which is a separate matter. It is also emphasised that cargo handling in the docks varies between one port and another and, therefore, each port needs separate consideration. The present enquiries were concentrated on the ports of London, Liverpool (and Birkenhead), Manchester, Glasgow and Southampton, and each of the ports is reported on separately. However, a common factor to all of them is the very large amount of work, involving heavy capital expenditure, that has been and is being done by the port authorities to improve their facilities. This work has been carried out, concurrently with the repair of war damage and with the overtaking of maintenance which fell into arrears during the war, during a period of stringency of materials and labour and financial restrictions. In London and Liverpool a significant feature is the increase in the post-war years in the total volume of export traffic passing through the port and the much greater proportion of that traffic which is road-borne.

The enquiries have shown that the delays are, in the main, limited to road vehicles loaded with general export cargoes, particularly though not exclusively those consigned to deep-sea ships bound for distant destinations. The problem of clearing road vehicles is governed by the speed with which cargoes can be received in the docks, and this in turn is governed by a number of factors such as the supply and mobilisation of labour, the conditions of work, the assembling, sorting and clearing of cargo through sheds, and the loading and stowing in the ships in the order necessary for the trim of the ship and for rotation of discharging ports. An even flow can only be achieved by the co-operation of all parties concerned and by dove-tailing the various operations in an orderly manner.

London.

Regarding the position in London the report states that the P.L.A. have kept records of the numbers of vehicles with export goods handled in the docks and of those which have had to be turned away at night without being unloaded. Difficulties arise mostly in the Royal Group, though other docks, particularly Tilbury and the West India group, have also been affected at times. Figures are given for four weeks ended October 29, 1955, for vehicles. These show that 56,341 lorries were unloaded and 833 were turned away; 9,792 rail trucks were unloaded. Reasons for turning vehicles away were classified by the P.L.A. under three heads:—

Vehicles arriving late in the day (526).—This accounted for the greatest number not dealt with on the day of arrival, and frequently occurred in the last two or three days of the advertised receiving period.

Congestion in Shed (28).—This may be due to a ship arriving at her berth later than was expected owing to bad weather, delay in discharge of previous cargo, or delays in dry-docking, or it may be due to cargo which should have been loaded in an earlier ship being left in the shed.

Other reasons (297).—The unloading of 250 vehicles was prevented by heavy rain which occurred on three days during the week ended October 22. The other vehicles shown under this heading either arrived after work had ceased or were carrying hazardous goods which had been sent down on the wrong day and could not be accepted.

Increase in export traffic and of the proportion handled by road vehicles is illustrated by the following figures:—

	Tons	Rail	Road
1937 ...	728,813	301,824	426,989
1955 ...	1,975,603	378,962	1,596,641

The volume of goods by rail increased by some 25 per cent., but road traffic increased by nearly 275 per cent.

The docks were originally laid out for very different conditions, and it is this great increase in road transport which gives rise to the existing difficulties. In addition to the volume of goods passing over the quays, an approximately equal quantity is also taken to ships by lighters and loaded over the waterside. This fact is significant in considering suggestions which have been made for saving the time of road vehicles by unloading goods into depots up-river and taking them to the ships by lighter.

The report states that the P.L.A. receive no advance information about the amount of cargo which is being sent to any particular ship on any day. Sufficient men are engaged at the morning call to enable estimated requirements to be met, but experience may show that road vehicles are coming in faster than they can be unloaded. The Authority then try to engage more men at the mid-day call, but may not always be able to do this, so that some vehicles are likely to be turned away without being unloaded.

The heavy volume of traffic requires advance planning but, the report points out, there are limits to the extent to which the movement of ships can be accurately predicted.

Transit sheds on the quays are designed on the assumption that there will be a reasonably steady flow of goods through them. They cannot hold all the cargo for one ocean ship and if circumstances prevent the cargo being moved through continuously, the shed becomes full and the unloading of vehicles is retarded. The problem would be eased if sheds were larger, but it is realised that at some berths enlargement of the sheds may be physically impossible. The economic justification must also be taken into account, the additional overhead costs of a larger shed represent an addition to the costs of handling cargo through the port. Nevertheless, the Committee is of the opinion that improvement of shed accommodation within the limitations set out above, is a necessity.

Regarding a suggestion that depots be provided outside the docks, the report points out that this method involves double handling, and, so far as onward conveyance by water is concerned, would not be practicable in many cases because there is usually no more room for additional craft on the waterside of the ship. With a view to expediting the unloading of small lots and reducing the number of vehicles at the ship berths, the P.L.A. have already provided depots at the Royal Docks and India and Millwall Docks for the reception of small consignments up to a total weight of 20 cwt. The Authority undertake to sort these consignments to ships and destination ports and to transfer them to the loading berth in time for shipment. The report advocates that these facilities should be more widely publicised and greater use made of them.

There are many factors which have led to the development of road transport for the conveyance of export goods, but the economic cost involved in keeping a road vehicle waiting to unload is greater than that incurred with a railway wagon, since a road vehicle has to be manned. A swing back from road to rail transport would materially help to ease the problem and the report welcomes the re-opening by British Railways of the "Green Arrow" service for full wagon loads of export cargo, which gives a guaranteed date of delivery at the port. It is suggested that exporters and British Railways should explore the possibilities of small lots being bulked at the larger sending stations in the Midlands and elsewhere so as to make full wagon loads for individual ships.

The working of longer overtime to clear road vehicles would ease the position, and also there is room for some control of the time of arrival of the vehicles.

British Road Services have recently introduced into the London Docks a scheme for the control of their vehicles by radio, which has already been operating successfully for three years at Liverpool and Birkenhead. This system helps to ensure an orderly flow of vehicles though its use is, of course, confined to vehicles under one control.

The report recommends that Shipping Conferences, shippers and the Port of London Authority, working as necessary through the

Ports Efficiency Committee Report—continued

Port Operations Panel and the Port Users' Committee, should co-operate in the preparation of schemes for regulating the calling forward of traffic on a voluntary basis. An essential part of any such schemes would be that the cargo booked for any particular ship should not exceed the capacity of the ship. Cargo could be regulated in times of congestion, but the schemes should be so framed as to ensure that the volume of goods handled through the port is maintained and that ships are not kept waiting for cargo. They should also provide that the reception of cargo is spread over the whole receiving period. Staggered dates should be notified to shippers, and should be adhered to strictly, subject to special arrangements to meet particular difficulties of individual consignors.

Liverpool.

The problem of dock delays does not appear to be quite so serious in Liverpool and Birkenhead as in London, but in so far as it exists, it arises mainly from the increase in total volume of export traffic and in the proportion which arrives by road. There are many features of port working at this port which differ from those in London. Apart from the different arrangements for the reception of export cargo, a permit scheme is operated. At present, the procedure adopted by shipowners is: (a) to indicate specific dates for heavy lifts, perishable, hazardous or deck cargo, goods to be loaded overside, vehicles or other special loads; (b) to indicate special dates or an actual date for reception of large consignments; (c) as regards deep port cargo, either to indicate specific dates or to ask for certain goods to be tendered first where similar cargo is going to a number of ports; (d) in many other cases to indicate specific dates or block dates; (e) in other cases to receive cargo as tendered.

Cargo tendered out of date is accepted unless special circumstances make this impossible. While this system is of material assistance, it is felt it could be made more effective.

Manchester and Glasgow.

The Port Operations Panel in Manchester have had the matter of road delays under study for some time and shipping lines using the Port have appealed to shippers to spread their deliveries evenly over the whole receiving period. The Canal Company are widening some of the roads in the docks and improving parking facilities for road vehicles to make easier the systematic queueing and calling on of vehicles. A point with considerable bearing on the delays problem is the extent to which deliveries of cargo are delayed until the end of the weekly receiving period. It was found that a number of drivers, particularly those employed by small firms, were under the impression that some saving of quay rent would be ensured by late delivery. This is not so; no quay rent is charged against the shipper for export goods.

It is considered that time needed to unload a road vehicle could be considerably reduced if more attention were paid to the packaging of goods and if they were loaded on the lorries with regard to the requirements at the unloading end. It would be an advantage if crated traffic could be fitted with skids to facilitate the use of fork-lift equipment.

Statistics relating to delays to road vehicles at Glasgow are not available. It is understood, however, from the Port Transport Executive that delays to road vehicles rarely occur.

Southampton.

At Southampton the problem of delays to road vehicles is confined to export traffic for South Africa, and the last occasion when difficulty was experienced was in June and July 1955, when the South African Government announcement of impending import restrictions coincided with a dock strike in London. As a result, exporters from all over the country despatched large quantities of goods by rail and road without previous notice to the Shipping Company and without booking space, in the hope that they would secure shipment.

Conclusions and General Recommendation.

In their conclusions and general recommendations the Committee recommend the adoption of two courses to meet the problem in the ports. The first is to increase the available shed accommodation. This can be done by building larger sheds where this is physically possible and economically justifiable, and by improving the layou of sheds and working methods. The second course, to which th Committee attaches the greatest importance, is to introduce regula tory schemes whereby:—

(1) all those responsible for the handling of traffic can be awar from day to day of the cargo expected to arrive;
(2) dates for the reception of cargo are staggered so that the good to be loaded first arrive at the beginning of the reception period, and are followed by those to be loaded later;
(3) the unnecessary peaks which at present occur at the end of a receiving period are avoided.

Only in abnormal conditions would it be necessary to hold traffic back and any scheme would need to be worked so that the maximum flow of traffic was maintained, and there was no risk of wasting ships' time or space because cargo was not available. In Liverpool arrangements are in operation which meet some of the needs of the situation, but are capable of improvement; in Manchester a scheme would be advantageous. It is, however, in London that there is the greatest need and it is recommended to shipowners and shippers, on whom the responsibility primarily rests, that they should introduce regulatory schemes as soon as possible.

Other recommended measures of general application are a more extensive use of rail transport for export cargoes, especially now that the " Green Arrow " service has been restored, and the creation of depots by road hauliers at which small consignments of export goods can be bulked so as to reduce the numbers of vehicles waiting in dock areas.

In an appendix the Committee refer to a recommendation in their second report that to accelerate the turn-round of grain ships work should go ahead on mills at London, Manchester, Hull and Leith. All the mills are now in operation. The second report also commented on the slow rate at which mechanisation was being introduced at ports. Since then considerable progress has been made in regard to bulk cargoes such as ores, sugar and grain. The Committee hope that it will be possible for employers and men to reach agreement on the progressive introduction of mechanical equipment for handling general cargo.

The National Association of Port Employers.

At the Annual General Meeting of the National Association of Port Employers, held on April 19th, 1956, Mr. R. H. Senior, D.S.O., T.D. (Deputy Chairman and a Managing Director of Port Line Ltd.) was re-appointed Chairman of the Association. Sir Leslie Roberts, C.B.E. (Chairman of the Manchester Ship Canal Company) and Mr. T. M. Lawrie (Chairman and Managing Director, Roxburgh, Colin Scott & Co. Ltd., Glasgow) were re-appointed Vice-Chairmen, and Sir Leslie Ford, O.B.E. (General Manager of the Port of London Authority), Honorary Treasurer.

Meetings of the Société Hydrotechnique de France.

The Société Hydrotechnique de France has organised " IV° Journées de l'Hydraulique," which are to be held from June 10—13, 1956. The subject to be studied during the course of the meetings will be " Les Energies de la Mer," the papers being subdivided under the two headings of Mechanical Energy and Thermal Energy.

The papers to be delivered and discussed during the four days have been contributed by hydrotechnical engineers from many countries. They deal with such subjects as the recording of natural surge; the influence of tidal energy in the English Channel; attempts with models to estimate the power of non-lineal surge, the stability of maritime structures, formation and evolution of beaches; the study of infiltration in rock breakwaters and other experiments with tidal models. There are also papers on the possible uses to which surge and tidal energy can be put and, conversely, on their noxious qualities such as the effect of a tidal wave on the mooring of ships, and the effects of surge on silting and on maritime defence works. The section of Thermal Energy contains papers on laboratory experiments with conclusions on the possible uses to which such energy could be put.

The Distribution of Wave Heights

A Statistical Method Based on Observations

By J. DARBYSHIRE, M.Sc.
(The National Institute of Oceanography, Wormley, Surrey).

It is important for many purposes such as the building of dams and breakwaters to be able to make a statistical estimate of the state of the sea. One measure commonly used is the "significant wave height" which is the mean height of the highest third of the waves observed in a given time interval, usually 10 to 15 minutes. Other ways of expressing sea state are the mean height of the highest tenth of the waves and the maximum height recorded. Jasper (1955) using U.S. weather ship data has found that the significant wave height follows a definite statistical distribution in which its logarithm is distributed about a mean value according to the normal error law so that

$$y = A \exp -(\log x - \log a)^2 / b^2$$

where y is the probability density, x is the significant wave height, and a the most probable value of x. This formula is based on 12,000 observations taken from weather ships at station C (52°00′N, 37°00′W) at intervals of three hours over a period of 4½ years. A formula of the same kind was also obtained from observations for several years taken by merchant ships in the North Atlantic and North Pacific.

This paper checks this distribution for wave heights at other points. The O.W.S. "Weather Explorer" has since February 1953, taken records of waves every three hours while she is at sea (Darbyshire 1954), using a ship-borne wave recorder (Tucker 1952, 1956). Three years' observations are now available, most of which have been taken at stations "India" (61°00′N, 15°20′W) and 59°00′N, 19°00′W) and "Juliett" (52°30′N, 20°00′W). In addition, the French authorities have taken wave measurements at Casablanca since 1952 and have kindly supplied daily values of the mean of the highest tenth of the waves to the National Institute of Oceanography for the period 1952 to 1955. Waves were also recorded every four hours at Perranporth, Cornwall from October 1945 to January 1947.

The weather ship data are presented in Fig. 1. The maximum wave height is used as the parameter denoting the sea state. The height is plotted on the x axis and the percentage of time waves exceed a given height on the y axis. The scales of the graph are arranged as was done by Jasper so that the points fall on a straight line if the logarithmic normal distribution law holds. It is seen that they lie very close to a straight line from about 4½-ft. to 45-ft. but there is a marked departure from linearity outside these values. These limits of linearity compare fairly well with the range of values for significant wave height found by Jasper which was 2½-ft. to 30-ft. since the maximum wave height is approximately 1.5 times the

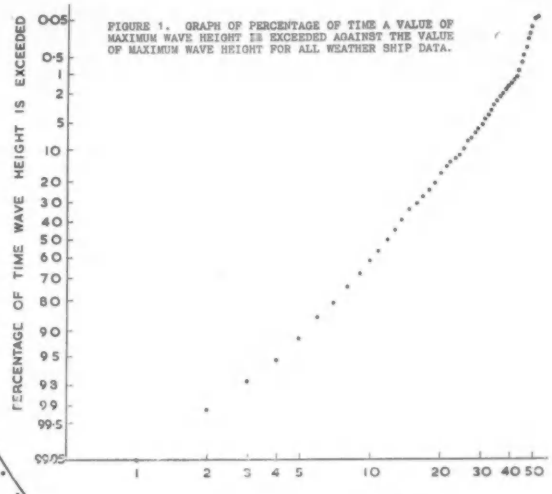


FIGURE 1. GRAPH OF PERCENTAGE OF TIME A VALUE OF MAXIMUM WAVE HEIGHT IS EXCEEDED AGAINST THE VALUE OF MAXIMUM WAVE HEIGHT FOR ALL WEATHER SHIP DATA.

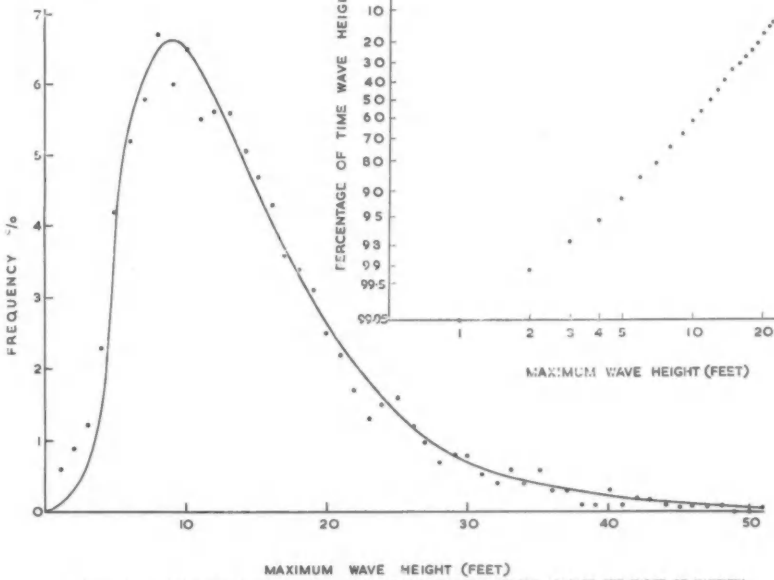


FIGURE 2. FREQUENCY OF OCCURRENCE OF VALUE OF MAXIMUM WAVE HEIGHT AGAINST THE VALUE OF MAXIMUM WAVE HEIGHT FOR ALL WEATHER SHIP DATA.

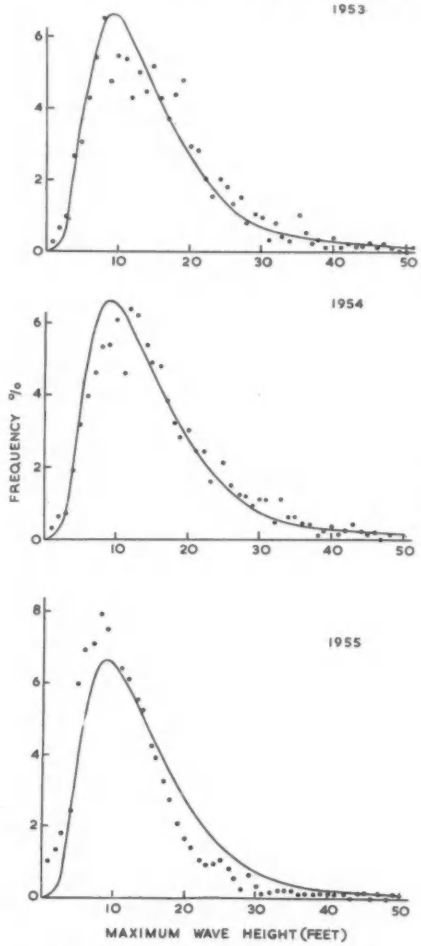


FIGURE 3. FREQUENCY OF OCCURRENCE OF VALUE OF MAXIMUM WAVE HEIGHT PLOTTED AGAINST MAXIMUM WAVE HEIGHT FOR 1953, 1954, AND 1955 SEPARATELY.

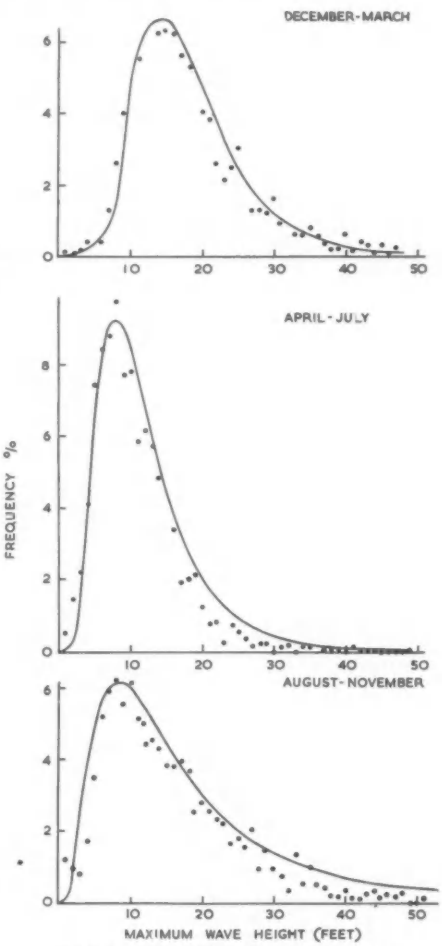


FIGURE 4. FREQUENCY OF OCCURRENCE OF VALUE OF MAXIMUM WAVE HEIGHT PLOTTED AGAINST MAXIMUM WAVE HEIGHT FOR WEATHER SHIP DATA FOR DECEMBER-MARCH, APRIL-JULY, AND AUGUST-NOVEMBER.

The Distribution of Wave Heights—continued

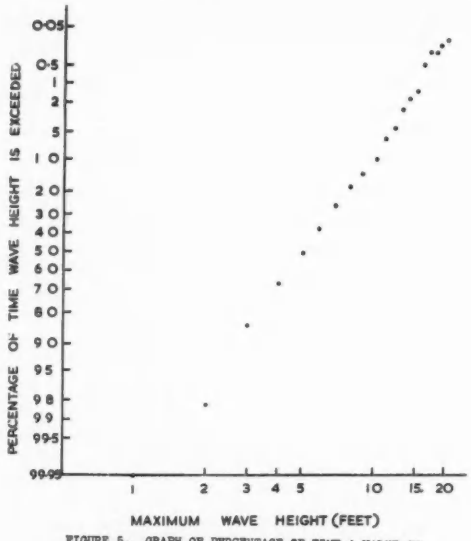


FIGURE 5. GRAPH OF PERCENTAGE OF TIME A VALUE OF MAXIMUM WAVE HEIGHT IS EXCEEDED AGAINST THE VALUE OF MAXIMUM WAVE HEIGHT FOR ALL CASABLANCA DATA.

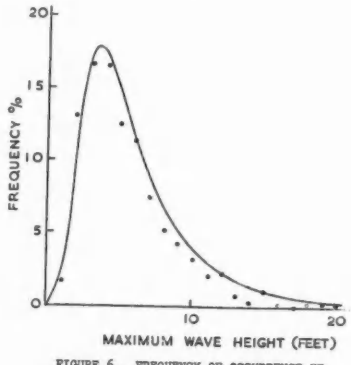


FIGURE 6. FREQUENCY OF OCCURRENCE OF VALUE OF MAXIMUM WAVE HEIGHT AGAINST THE VALUE OF MAXIMUM WAVE HEIGHT FOR ALL CASABLANCA DATA.

significant wave height (Darbyshire 1952). The weather ship data consisted of 4,786 observations.

Although it may not be accurate for very low and very high values of x, the logarithmic normal distribution is a very useful one to use. In Fig. 2, the observations are split into classes of 1-ft. interval and the percentage in each class is plotted. The points so obtained all fall very nearly on the distribution curve shown which is given by

$$y = 6.6 \exp - (\log x/9)^2/0.126$$

In Fig. 3, the same curve is compared with the observations for 1953, 1954, and 1955 shown separately. The fit is still good for each year. This suggests that a satisfactory estimate of the distribution curve can be obtained from observations for one year. The distribution would, however, be expected to change at various seasons of the year, and Fig. 4 shows the data split up into three groups; the first group includes observations taken in December, January, February, March, the second group those taken in April, May, June, July, and the third August, September, October, November. Distribution laws of the same form can be fitted for these three groups and those shown in Fig. 4 represent

$y = 6.6 \exp - (\log x/14)^2/0.065$ for December to March,

$y = 9.2 \exp - (\log x/8)^2/0.104$ for April to July,

$y = 6.1 \exp - (\log x/8)^2/0.137$ for August to November.

Figs. 1 to 4 are based on weather ship data. The wave data for Casablanca are dealt with similarly. The plot of the percentage of the time waves exceed a given height is shown in Fig. 5 and the points again lie very close to a straight line though the range of heights recorded is not so large as that from the weather ship. The percentage of waves in each 1-ft. class are plotted against the heights in Fig. 6 for the years 1952 to 1955 and the points lie about the curve shown which is given by

$$y = 18 \exp - (\log x/3.5)^2/0.137$$

The four years are shown separately in Fig. 7 and the fit is still good for each year.

The logarithmic law thus appears to be a useful guide to determine the incidence of a particular wave state at a given point and if observations for one year are available, a close approximation to the distribution law can be obtained. This is done in Fig. 8 for Perranporth where a complete year was taken, the observations being split into 1-ft. classes as before and a distribution law obtained which is

$$y = 13 \exp - (\log x/4)^2/0.199$$

The author wishes to thank the Director of the Meteorological Office and the Superintendent, Marine Division, Meteorological Office, for the use of the wave records taken by the O.W.S. "Weather Explorer," and also the Chef de Service du Globe et de Meteorologie, Casablanca, for the Casablanca observations.

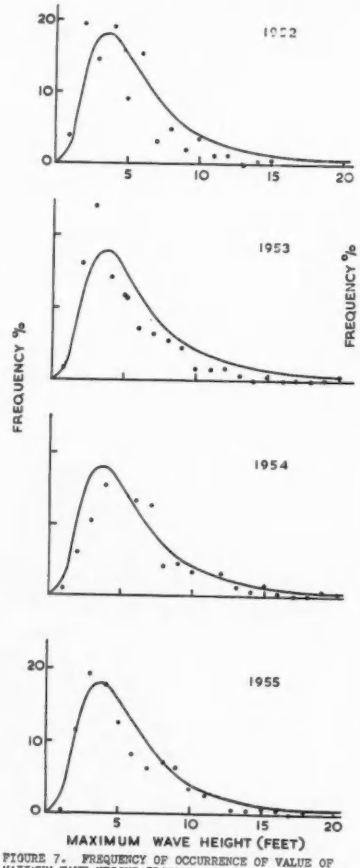


FIGURE 7. FREQUENCY OF OCCURRENCE OF VALUE OF MAXIMUM WAVE HEIGHT PLOTTED AGAINST MAXIMUM WAVE HEIGHT FOR CASABLANCA FOR 1952, 1953, 1954 AND 1955 SEPARATELY.

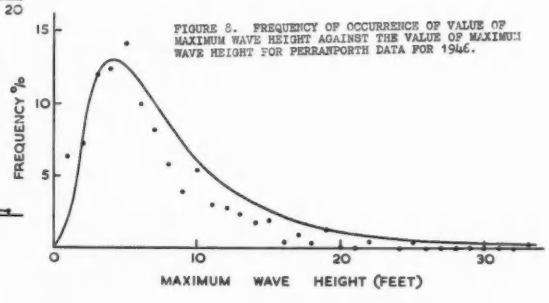


FIGURE 8. FREQUENCY OF OCCURRENCE OF VALUE OF MAXIMUM WAVE HEIGHT AGAINST THE VALUE OF MAXIMUM WAVE HEIGHT FOR PERRANPORTH DATA FOR 1946.

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Measurement of Deep-Sea Currents.

For the first time, direct and reliable measurements of the currents in the deep ocean basins have been made free from the uncertainties involved in using a conventional current meter from an anchored ship. Dr. J. C. Swallow, of the National Institute of Oceanography, has developed a technique whereby a neutrally buoyant float can be followed for several days by listening to the acoustic signals that it transmits. The density of the float, which consists principally of two 10-ft. aluminium scaffold tubes sealed at the ends, is carefully adjusted to be greater than that of water at the surface of the sea and less than that of the bottom water, so that it floats at a pre-determined depth in mid-water.

Measurements so far have shown that even in mid-ocean the tidal current is considerable and that there is also a steady current, which in the area investigated amounted to a mile a day. These currents are of great importance to an understanding of the water circulation which transports large amounts of nutrient salts from one part of the ocean to another and exert a marked influence on the distribution of marine animals. They have recently become of further practical interest with regard to the disposal of radioactive waste in the deep sea.

Pneumatic Discharge of Water-Borne Coal

Handling Plant at Manchester

One of the most interesting applications of pneumatic handling is to be seen in the conveyance of coal in power stations. Among the installations of this type in this country, there are two public electricity supply stations using pneumatic handling for coal: the others are in privately-owned factory steam raising plants.

The pneumatic coal handling plant at Trafford Generating Station, Manchester, is of considerable interest. There are two pneumatic plants at this station. One was built and put into service in 1926 (and overhauled in 1944), has a rated capacity of 30 tons/hr., has given satisfactory and efficient service during its thirty years' work and still maintains its rated capacity. Operated by a single-cylinder vacuum pump there has been little wear even though the plant is in use every working day, other than for periodical shut-downs for maintenance.

The second plant, installed in 1941, has a rated capacity of 80 tons/hour and is operated by a twin-cylinder pump. The plant works (under good condition) at some 95 tons per hour and, in fact, the conveyor belts it serves were speeded up by 50 per cent. in 1944 to cope with the increased output. These two pneumatic plants are part of a complete pneumatic/mechanical coal-handling plant dealing with water-borne coal, which is discharged pneumatically from barges and conveyed by belts to the boiler house bunkers. Coal is reclaimed from the stockpile by a drag scraper and delivered to the boiler house belt conveying system.

Trafford Generating Station is on the Bridgwater Canal which, at this point, runs parallel to, and is only about a quarter of a mile from, the Manchester Ship Canal.

Freight costs are kept to a minimum by making all deliveries by barges from collieries within a short radius of the station. Two types of power-driven barges make the deliveries—" narrows " (capacity 25 tons) and " flats " (capacity 60 tons).

The barges, part of an extensive fleet serving power stations in Lancashire, operate a continuous service between the station and the collieries. The owners of these barges have expressed a preference for Trafford Generating Station because pneumatic intake pipes are less likely to damage their wooden boats than the crane grabs used elsewhere.

Trafford uses some 4,000 tons of dry smalls every week. A certain amount of coke breeze is also used. The smaller plant can discharge up to 1,800 tons per week and only one man is required to handle the intake pipe. With the larger plant, about 4,750 tons can be handled weekly during normal working hours. In this case, since there are two intake pipes, there are two nozzle operators. They can work simultaneously on one or two barges.

At Trafford Generating Station it is not necessary to run a number of shifts on coal handling, a common practice at some other stations. If there was an emergency, however, the coaling plants could be worked continuously and in that event they would discharge some 2,200 tons per 24 hours. In fact, over two million tons of coal have been handled by the 1941 plant since it was commissioned. Sufficient coal can be handled to maintain the station as a " base-load " station (i.e. running 24 hours a day) during a normal working day—7.30 a.m. to 5 p.m.

Although it is well known that pneumatic plants require more power per ton than some other types of handling plants, their other advantages result in lower overall costs. There is a saving in labour cost by reducing manpower and maintenance costs are considerably less than on grabs, telphers and cranes.

One of the main advantages is that cargoes can be completely discharged from the barges—in contrast to other methods where there is usually a small amount of coal left in the hold. Although this may not be of great value as far as one load is concerned it does total a considerable tonnage over a year. For example, 80 barges are discharged per week: if only one hundredweight was left in each, the annual wastage would be about 200 tons, or £800.

Another advantage of pneumatic coal handling is its cleanliness, and at Trafford no dust is to be seen from the discharge point to the storage bunkers—a very important factor to the operator in charge of the pneumatic intake nozzle, and in the field of industrial diseases. A further advantage is that the amount of manual work is considerably cut down compared with other methods and trimming is practically eliminated. The operator simply inserts the nozzle into coal and works systematically from one end of the barge to the other.

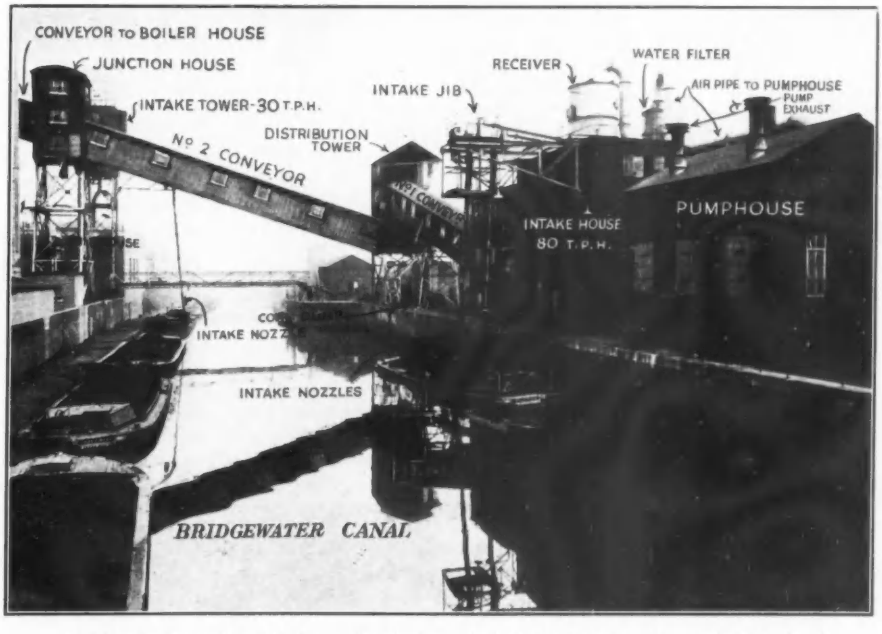
Description of Plant.

The following description is of the 80 tons an hour plant; both were manufactured by Simon Handling Engineers Ltd., of Stockport, Cheshire, and the design of the smaller installation is basically the same.

The plant has two suction pipe booms which are telescoped by electric winches controlled by push-button stations attached to the intake ends of the pipes. This allows the operator to control the movement of the booms from the barge he is unloading. Although electrically operated, safety in all types of weather is ensured because the power at this point is only 25 volts.

The suction nozzle consists of a short section of pipe with an annular sleeve, and a hand-controlled valve for regulating the amount of air entering the suction pipe so that the coal is drawn in a state of loose suspension by a fast-moving stream of air.

The coal is drawn vertically from the barge for some 50-ft. through flexible and telescopic piping and is then discharged by an inclined pipe boom into a receiver, where the expansion and loss of velocity of the conveying air stream allows the coal to fall into the lower portion of the receiver. The coal is then released from the receiver by a standard vacuum tipper seal. This consists of two compartments, each of which is alternately brought under the receiver outlet by mechanically oscillating the tipper from side to side. While one compartment is under the outlet and receiving coal under vacuum (its swinging discharge door being meanwhile held shut by atmospheric pressure) the other compartment is open to atmosphere, breaking the vacuum and allowing its discharge door to open and release the contents into the discharge hopper below. The coal is then fed by a tray-type



Trafford Generating Station, Manchester. Left bank: 30 tons/hr. and Right bank: 80 tons/hr. pneumatic intake plants.

Pneumatic Discharge of Water-Borne Coal—continued

coal feeder to a moving belt which conveys the coal to the boiler-house bunkers.

Special means are used to deal with fine particles of dust which do not settle at once in the receiver but remain suspended in the air and might be drawn into the vacuum pump and cause damage. A primary dust-collecting cyclone is fitted inside the receiver which collects the bulk of the fine suspended particles and discharges them into the hopper through a standard dust seal.

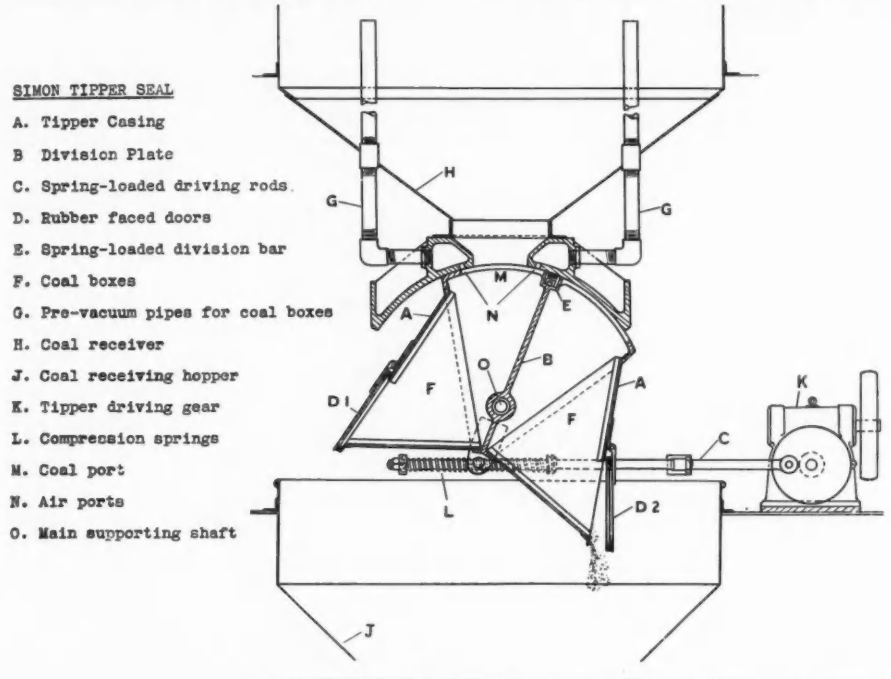
The dust seal used is a rotary discharger which consists of a revolving drum with a number of radial compartments which are in turn brought under the dust outlet, each compartment being pre-exhausted in the same way as the tipper seal. The compartments receive dust as they pass the outlet and release it when they pass the opening in the bottom of the housing.

Any material or light dust which escapes the influence of the internal cyclone is carried by the air stream into a water filter where the air is sprayed with water which carries away the remaining dust to a sludge tank. The water and coal dust mixture is drained away from the tank continuously by a regular flow of clean water and the tank acts as an air seal.

It is now necessary to return to the conveying air stream and trace its path to the vacuum pump. After the air has been sprayed in the water filter, it is drawn through a coke bed in the upper half of the filter in order to dry it.

Clean, dry air is, therefore, drawn to the pump. Before reaching the pump, however, it passes through an air receiver fitted to cushion the pulsating action of the reciprocating pump: a steady, even flow of air is essential in the pneumatic conveying system The air receiver contains, as a safety precaution, a perforated grid. If by mischance foreign matter is drawn beyond the water filter, it cannot enter the pump and cause damage.

Close-up of intake nozzles.



The pump is of special design for this class of work having valves easily accessible for inspection or renewal and piston-rings with dry graphite lubrication. It is of the double-acting reciprocating type, with ring-oiling bearings for the main crank-shaft and mechanical lubrication to the reciprocating parts. The cylinders are carried on "A" frames supported on heavy cast iron bed plates, and the crankshaft is extended to carry a flywheel. There is a centrally-mounted bush-roller chain drive. The cylinder covers have quick-operating inspection doors, so that the valve units, which are complete in themselves, can be inspected conveniently. The vacuum pump is driven by a 175 b.p.p. motor.

Finally the air is passed to atmosphere through twin exhaust pipes.

Maintenance of both plants does not interfere with discharging periods—it is carried out quite comfortably during meal breaks.

The British Industries Fair, Birmingham

Exhibits of Interest to Dock and Harbour Authorities

It is some thirty-six years ago since the first Engineering and Hardware Section of the British Industries Fair was held at Castle Bromwich, Birmingham. During this period there have been great advances in design and technique, but perhaps the greatest development may be found in mechanical handling equipment. Visiting the Fair regularly year by year, this may not be so apparent but, nevertheless, no year passes without there being something new to be seen, and 1956 is no exception.

In the course of a speech made by Mr. J. Ivan Yates, Chairman of the Fair Management Committee, reference was made to the development of the country's export potential. The British Industries Fair is an unrivalled shop window for foreign buyers and the goods displayed are deserving of all the publicity which the Press can give them. But with the best will in the world, correspondents who visit the Fair on Press Day (the Friday before it opens) cannot do justice to many exhibits when the stands are incomplete and the firms' representatives are not in attendance.

Only two ports made any bid for export traffic at the Birmingham section of the Fair—Newport (Mon.) and London—and it is to the credit of these ports that there were representatives in attendance. Newport had a number of photographs for distribution and had issued a folder, "Why not Newport?" which sets forth briefly the facilities of the port. The Port of London Authority had published for the Fair an "Exporters' Guide," which is a handbook intended to provide a background of information on procedure and on the facilities available to the exporter in his use of the docks of London. It takes the place of the former "Export Handbook," a revised edition of which was always available at each British Industries Fair.

Among the exhibits of interest to readers of "The Dock and Harbour Authority" were various types of material handling equipment, including shelving, chain, belt and gravity conveyors, and open steel flooring which was exhibited by Fisher Ludlow, Ltd. Fork lift trucks exhibited ranged from 2,000 lb. to 18,000 lb.

British Industries Fair—continued

capacity. Operated by petrol, diesel and electric batteries, some of them accommodate a driver; others are pedestrian controlled. One model can make a complete turn in a radius of 5-ft. There was also a variety of attachments for specialised work.

R. H. Corbett and Co. Ltd., one of the few firms which exports mechanical handling equipment to the United States, exhibits a new end-loading drum rack, fitted with a self-loading drum gate. This two-tier rack holds eight 40-gallon barrels in each tier. The design has been perfected so that when a barrel is removed the next barrel automatically rolls into position.

Felco Hoists, Ltd. have designed an hydraulic lorry-loader for handling cylindrical objects such as drums, barrels, casks, newsprint reels, etc. The lorry-driver can load or unload single-handed three tons of 40-gallon drums in five minutes, an operation which would normally take two men more than half-an-hour.

New types of pallets exhibited by Victrolec Ltd. included a "fold-flat" pallet designed to stack away flat when not in use.

Simon Engineering (Midland) Ltd. showed for the first time a 30-ft. hydraulic platform, mounted on three different forms of vehicles, which have many applications in industry. This model is a development of their 40-ft. model, which was introduced last year and was designed for work in oil refineries, building contracting and civil engineering.

Scaffolding (Great Britain) Ltd. showed their lattice shell construction, an economical system for roofing over large spaces and giving adaptability in design.

Rainham Timber Engineering Co. Ltd. had erected a large shed to demonstrate a technique in construction by the use of trusses made of glued laminated timber, which can support spans of up to 120-ft. It is claimed that these trusses are considerably lighter than those of conventional materials, and that they require no painting and are unaffected by the severe atmospheric conditions of industrial and seaside areas.

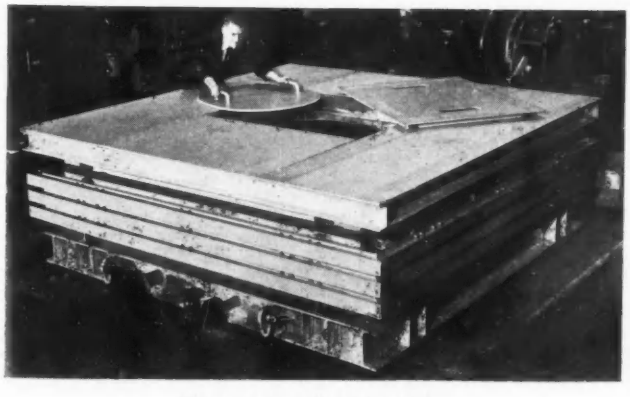
Manufacturers' Announcements

Collapsible Tank for Bulk Cargoes

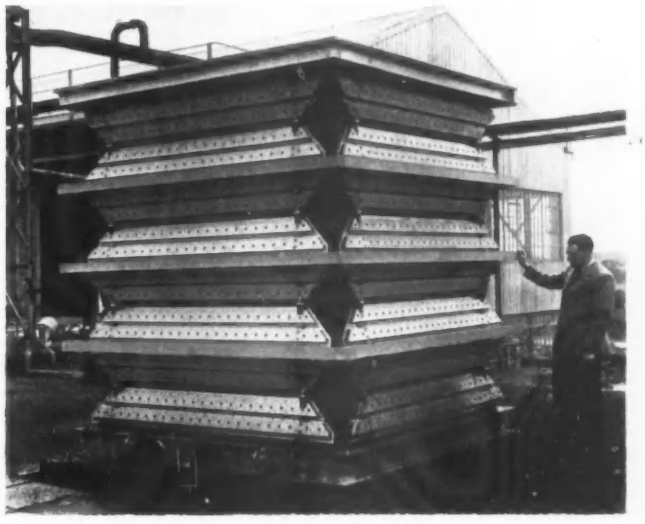
A prototype of a collapsible cargo tank, devised by R. & H. Green and Silley Weir, Ltd., has been designed and manufactured by Marston Excelsior, Ltd., Wolverhampton (an I.C.I. subsidiary), and has completed its initial tests prior to more extensive sea-going trials in the near future.

This invention may prove of considerable value to shipping companies and other freight transport concerns by enabling fuller use to be made of capacity on previously unladen voyages.

The collapsible tank, which, broadly speaking, works on the concertina principle, provides a new method of transporting bulk fluids—crude oil, petroleum products, edible oils, wines, cresote, etc.—while also providing facilities for carrying dry commodities by the same vessel without having to remove the tanks. Basically, the unit comprises a collapsible fabric reinforced synthetic rubber bag, housed in light alloy telescopic shuttering. When extended, the tank would accommodate bulk fluid on a ship's outward voyage



The tank in collapsed position.



The tank fully extended.

and on the return journey it would be collapsed for the transport of solid cargo, the top of the tank becoming the deck loading surface. The load would be borne by special internal supports.

The prototype tank is 8-ft. cube in size, and has a capacity of 2,900 gallons. It can be erected by air inflation, an air pressure of $\frac{1}{2}$ to $\frac{3}{4}$ lb. per sq. in. being sufficient to extend the tank, or by mechanical means by the hydraulic pressure of the liquid cargo which is to be carried. The tank, which can be secured to the deck or hold by stanchions, is self-supporting when loaded and has been designed to permit a roll of 20 degrees on either side of the vertical with a period of eight seconds.

The flexible bag is made of four-ply material, fabric and synthetic rubber in alternate layers, on to which a lacquer can be applied when edible oils are carried. The framework is of aluminium alloy Kynal M.39/2 with mild steel hinges and pins, and is so designed that it not only protects the bag in the collapsed position but does not rub or pinch when the tank is full. It also maintains stability in the conditions allowed for on board ship.

The shuttering surrounding the bag consists of hinged leaves, themselves hinged to square frames at intervals of approximately 2-ft. when erected. Design of the sections is such as to allow extension almost to the 180 degree position without, however, coming to dead centre. If heavy oils are carried, coils can be fitted in the tank, whose base is also fitted for air injection if required.

The height of the tank and its supports when closed, is less than 3-ft. and when extended the height from tank top to the top of the frame measures 9-ft. $4\frac{1}{2}$-in. The deck loading surface (the top of the tank) is 8-ft. $9\frac{1}{4}$-in. square, with a deck loading of 400 lb. per sq. ft.

A manhole cover is provided and when cleaning is required, either a small portable tank cleaning apparatus is inserted, or a man can stand on the tank bottom whilst the tank is then raised round him enabling most effective removal of the deposits.

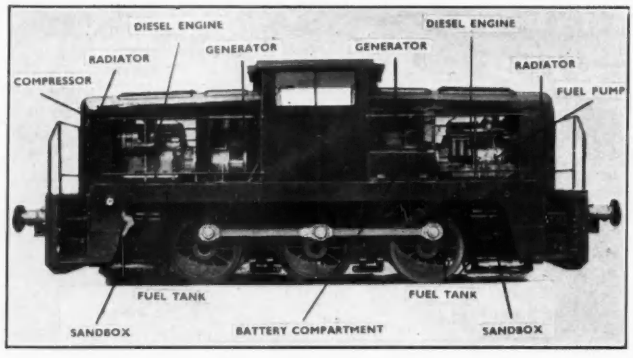
The prototype model is suitable for carrying crude oil and petroleum products and modifications to this are envisaged for containing edible oils, wines, etc.

New Diesel-Electric Locomotive

A new addition to the range of diesel-electric locomotives has been developed by Messrs. Yorkshire Engine Company Ltd. in collaboration with Messrs. British Thompson-Houston Co. This locomotive, named the "Janus," is being produced in two versions, 200 h.p. and 400 h.p. Both versions are fitted with Rolls-Royce diesel engines and B.T.H. transmission and are complementary to each other, the 400 h.p. model having two 200 h.p. diesel engines instead of one.

The adoption of the comparatively new Rolls-Royce oil engine, which is in the automatic range provides the "Janus" with an engine generator set considerably smaller than is usual in installations of this horse-power. This reduces both cost and maintenance

Manufacturers' Announcements—continued



The 400 h.p. "Janus."

and enables a smaller bonnet to be fitted, thus improving visibility from the cab.

The 400 h.p. locomotive is usually built as an 0-6-0 type for any gauge from one metre to 5-ft. 6-in. with reduction gear suitable for shunting requirements. It has a weight of 48 tons, a maximum permissible speed of 23 m.p.h. and a fuel capacity of 400 gallons. The 200 h.p. locomotive is produced in two types, 0-6-0 and 0-4-0, both types being identical as far as power equipment and weight are concerned, but for the 0-4-0 the overall length is reduced in proportion to the shorter wheel base. The weight of the model is 30 tons, the maximum speed 20 m.p.h. and the fuel capacity 200 gallons. The maximum tractive effort is 30,000 lb. for the 400 h.p. model and 18,000 lb. for the 200 h.p. model. The "Janus" is a rigid frame type of locomotive with axles coupled, overhung springing being provided in the axle boxes. Because of the ease with which it negotiates sharp curves, the "Janus" is ideal for port working. A substantial order has been placed by the Port of London Authority, and delivery is expected shortly.

Nylon Ropes for Marine Use

Nylon ropes are now being extensively used by commercial shipping organisations and are proving to be of great value in towing and mooring operations. Nylon is the first man-made fibre to achieve any notable success over traditional ropes, largely because of its combination of high tensile strength and elasticity, high flex strength and abrasion resistance, low specific gravity and moisture absorption, and immunity to attack by bacteria, insects and most chemicals.

The strength/weight ratio of a nylon rope is claimed to be at least double that of natural fibre rope and its elasticity means that the shock/resistance ratio is upwards of three times as great, making it possible to use a shorter rope than would otherwise be required. The Admiralty have recently carried out tests with nylon ropes, and are following these up by trial with nylon towing springs and hawsers. The nylon used in these ropes is manufactured by British Nylon Spinners Ltd. London, W.1.

Conveyancer "Load-Clamp"

Conveyancer Fork Trucks Limited, announce a completely new attachment designed to permit Unit Load Handling without resort to any form of Pallet. This is the "Load-Clamp" which has been developed in conjunction with Thomas Hedley and Co. Ltd. The Unit has been tested out on cartons (for which it was originally designed) crates, boxes and cases all with entirely successful results.

The Clamp is hydraulically actuated, and in order to eliminate damage to loads by Clamp pressure a novel pressure control valve is incorporated. This is conveniently placed in the control panel to permit the driver to select the optimum pressure for the load to be handled. With these additional features it is possible to handle every type of load. The steel Grip-Plates are of special construction and have double articulation features which adequately compensate for any slight irregularities in the Unit Load itself.

The general design of the arms is particularly noteworthy, since loads can be stacked with a gap between stacks as low as 3-in.

Mooring and Salvage Vessel

Richard Dunston Limited recently completed at their Thorne Shipyard a Steam Mooring and Salvage Vessel of welded construction for Messrs. Wm. Cory and Son Limited, London.

The vessel, which will be chiefly used for the lifting and laying of mooring buoys and the raising of sunken barges in the River Thames, has a B.P. length of 80-ft., a moulded breadth of 21-ft. and a moulded depth of 9-ft. 3-in.

The equipment comprises a strongly-braced cathead with a 20-ton S.W.L., fitted with 3 large sheaves. A heavy steel tube is welded between the cathead cheek plates for use during 60-ton hoists, which are made by purchase block from the deck anchorage, a recess below the tube is arranged for the anchor stowage; apron skids are fitted either side of the cathead for use when dragging chains aboard.

A special steam salvage winch by Clarke Chapman Limited is fitted with two independent wire rope barrels and warping drums and is capable of exerting a pull of 10 tons

A large well lighted salvage hold is arranged forward of the winch and is fitted with hatch, racks for gear and lockers. The hold is served by a 2-ton S.W.L. tubular steel derrick mounted on

Mooring and Salvage Vessel.

an unstayed tubular steel mast. A steel top mast telescopes down inside the fixed portion so that the lights are below the air draft line. The propelling machinery supplied by Plenty and Son Ltd. comprises one compound marine engine developing 250 I.H.P. at 300 r.p.m., complete with air, bilge and feed pumps and separate surface condenser.

The 150 tons/hr. Evans Duplex Salvage Pump is arranged to draw from or discharge overboard. Salvage hose connections are located P. and S. of casing side and one portable connection forward. Provision for water ballasting is arranged in the fore and aft peaks and the double bottom.

The machinery and electrical installation was carried out by the Shipbuilders.

FOR SALE

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APPOINTMENTS VACANT

CLYDE NAVIGATION TRUST

Applications are invited for the following appointments on the Engineering Staff of the Trust:

JUNIOR ENGINEERING ASSISTANTS. Salary scale £400 to £850 per annum. Commencing salary according to age and experience. Applicants should have had a good technical training and drawing office experience and should possess a University Degree or have passed Part I of the Associate Membership Examination of the Institute of Civil Engineers, or hold equivalent qualifications. Experience in harbour work would be an advantage.

The successful applicants may be required to pass a medical examination and become members of the Trustees' Superannuation Fund.

Applications stating age, qualifications, etc. are to be lodged with the Engineer, Clyde Navigation Trust, 16 Robertson Street, Glasgow, C.2 not later than Monday, 11th June, 1956.